PHILOSOPHICAL TRANSACTIONS,

OF THE

ROYAL SOCIETY

OF

LONDON.

FOR THE YEAR MDCCC.

PART III.

LONDON,

PRINTED BY W. BULMER AND CO. CLEVELAND-ROW, ST. JAMES'S;
AND SOLD BY PETER ELMSLY,
PRINTER TO THE ROYAL SOCIETY.
MDCCC.

PHILOSOPHICAL

TRANSACTIONS

OF THE

CONTENTS

OF THE

ROYAL SOCIETY

FOR

LONDON.

PRINTED BY W. PEARSON AND CO. CLIFFORD'S-INN-HOUSE, BY JAMES WY-
ATT, AND SOLD AT THE ROYAL SOCIETY.
MDCCC.

CONTENTS.

XIX. *Experiments on the solar, and on the terrestrial Rays that occasion Heat; with a comparative View of the Laws to which Light and Heat, or rather the Rays which occasion them, are subject, in order to determine whether they are the same, or different. Part* II. *By* William Herschel, *LL. D. F. R. S.* page 437

XX. *An Account of the Trigonometrical Survey, carried on in the Years* 1797, 1798, *and* 1799, *by Order of Marquis* Cornwallis, *Master-General of the Ordnance. By Captain* William Mudge, *of the Royal Artillery, F. R. S. Communicated by his Grace the Duke of* Richmond, *F. R. S.* p. 539

PHILOSOPHICAL

TRANSACTIONS.

XIX. *Experiments on the solar, and on the terrestrial Rays that occasion Heat; with a comparative View of the Laws to which Light and Heat, or rather the Rays which occasion them, are subject, in order to determine whether they are the same, or different.* By William Herschel, LL. D. F. R. S.

PART II.*

Read November 6, 1800.

In the first part of this Paper it has been shewn, that heat derived immediately from the sun, or from candent terrestrial substances, is occasioned by rays emanating from them; and that such heat-making rays are subject to the laws of reflection, and of refraction. The similarity between light and heat, in these points, is so great, that it did not appear necessary to notice some small difference between them, relating to the refraction of rays to a certain focus, which will be mentioned hereafter. But the next three articles of this Paper will require, that while we shew the similarity between light and heat, we should at

* For the First Part of this Paper, see page 293.

the same time point out some striking and substantial differences, which will occur in our experiments on the rays which occasion them, and on which hereafter we may proceed to argue, when the question reserved for the conclusion of this Paper, whether light and heat be occasioned by the same or by different rays, comes to be discussed.

ARTICLE IV.—*Different Refrangibility of the Rays of Heat.*

We might have included this article in the first part of this Paper, as a corollary of the former three; since rays that have been separated by the prism, and have still remained subject to the laws of reflection and refraction, as has been shewn, could not be otherwise than of different refrangibility; but we have something to say on this subject, which will be found much more circumstantial and conclusive than what might have been drawn as a consequence from our former experiments. However, to begin with what has already been shewn, we find that two degrees of heat were obtained from that part of the spectrum which contains the violet rays, while the full red colour, on the opposite side, gave no less than seven degrees;* and these facts ascertain the different refrangibility of the rays which occasion heat, as clearly as that of light is ascertained by the dispersion and variety of the colours. For, whether the rays which occasion heat be the same with those which occasion the colours, which is a case that our foregoing experiments have not ascertained, the arguments for their different refrangibility rests on the same foundation, namely, their being dispersed by the prism; and that of the rays of light being admitted, the different

* See 2d and 4th experiments, pages 258 and 259.

refrangibility of the rays of heat follows of course. So far then, a great resemblance again takes place.

I must now point out a very material difference, which is, that the rays of heat are of a much more extensive refrangibility than those of light. In order to make this appear, I shall delineate a spectrum of light, by assuming a line of a certain length; and, dividing it into seven parts, according to the dimensions assigned to the seven colours by Sir ISAAC NEWTON, in the fourth figure of the second part of his Optics, I shall represent the illuminating power of which each colour is possessed, by an ordinate drawn to that line. And here, as the absolute length of the ordinates is arbitrary, provided they be proportional to each other, I shall assume the length of that which is to express the maximum, equal to $\frac{47}{33}$ of the whole line.

Thus, let GQ * represent the line that contains the arrangement of the colours, from the red to the violet. Then, erecting on the confines of the yellow and green the line LR $= \frac{27}{33}$ of GQ, it will represent the power of illumination of the rays in that place. For, by experiments already delivered, we have shewn that the maximum of illumination is in the brightest yellow or palest green rays. † From the same experiments we collect, that the illuminations of yellow and green are equal to each other, and not much inferior to the maximum; this gives us the ordinates K and M. Then, by the rest of the same experiments, we obtain also the ordinates H, I, N, O, P, with sufficient accuracy for the purpose here intended. All these being applied to the middle of the spaces which belong to their respective colours, we have the figure GRQG, representing what may be called the spectrum of illumination.

* See Plate XX. † See page 262.

We are now, in the same manner, to find a figure to express the heating power of the refracted prismatic rays, or what may be called the spectrum of heat. In order to determine the length of our base, I examined the extent of the invisible rays, and found, that at a distance of two inches beyond visible red, my thermometer, in a few minutes, acquired $1\frac{1}{4}$ degree of heat. The extent of the coloured spectrum at that time, or the line which answers to GQ in my figure, measured 2,997 inches. If two inches had been the whole of the extent of the invisible part, it might be stated to be in proportion to the visible one as 2 to 3; but we are to make some allowance for a small space required beyond the last ordinate, that the curve of the heating power drawn through it may reach the base; and indeed, at $2\frac{1}{4}$ inches beyond visible red, I could still find $\frac{1}{2}$ degree of heat. It appears therefore sufficiently safe, to admit the base of the spectrum of heat AQ, to be to that of the spectrum of light GQ, as $5\frac{1}{4}$ to 3; or, conforming to the NEWTONIAN figure before mentioned, the base of which is 3,3 inches, as $57\frac{3}{4}$ to 33. Now, if we assume for the maximum of heat, an ordinate of an equal length with that which was fixed upon for the maximum of light, it will give us a method of comparing the two spectra together. Accordingly, I have drawn the several ordinates B, C, D, E, F, G, H, I, K, L, M, N, O, P, of such lengths as, from experiments made on purpose, it appeared they should be, in order to express the heat indicated by the thermometer, when placed on the base, at the several stations pointed out by the letters.

A mere inspection of the two figures, which have been drawn as lying upon one another, will enable us now to see how very differently the prism disperses the heat-making rays, and those

which occasion illumination, over the areas ASQA, and GRQG, of our two spectra! These rays neither agree in their mean refrangibility, nor in the situation of their maxima. At R, where we have most light, there is but little heat; and at S, where we have most heat, we find no light at all!

21st Experiment. The Sines of Refraction of the heat-making Rays, are in a constant Ratio to the Sines of Incidence.

I used a prism with a refracting angle of 61 degrees; and, placing the thermometer No. 4 half an inch, and No. 1 one inch, beyond the last visible red colour, I kept No. 2 by the side of the spectrum, as a standard for temperature.

	At $\frac{1}{2}$ inch.	At 1 inch.	Standard.
	No. 4.	No. 1.	No. 2.
0′	64	64	$63\frac{1}{2}$
2	67	66	$63\frac{1}{2}$
5	69	67	$63\frac{1}{2}$
8	$69\frac{1}{2}$	$67\frac{1}{2}$	$63\frac{1}{2}$

Here, in eight minutes, the thermometer at half an inch from visible colour, rose $5\frac{1}{2}$ degrees; and, at one inch from the same, the other thermometer rose $3\frac{1}{2}$; while the temperature, as appears by No. 2, remained without change.

I now took a prism with an angle of forty-five degrees, and, placing the thermometers as before, I had as follows:

55	55
59	57	$54\frac{1}{4}$
61	58	55
62	$58\frac{1}{4}$	55

Here we likewise had, in 10 minutes, a rise of 7 degrees in the

thermometer No. 4, and of $3\frac{1}{4}$ in No. 1; while No. 2 remained stationary.

I tried now all the three angles of a prism of whitish glass: they were of 63, 62, and 55 degrees; and I found invisible rays of heat to accompany all the visible spectra given by these angles.

I tried a prism of crown glass, having an angle of 30 degrees; and found invisible heat rays as before.

I tried a prism of flint glass, with so small an angle as 19 degrees, and again found invisible heat rays.

I made a hollow prism, by cementing together three slips of glass of an equal length, but unequal breadth, so as to give me different refracting angles: they were of 51°, 62° 30′, and 66° 30′. Then, filling it with water, and receiving the spectrum, when exposed to the sun, as usual, on the table, I placed the thermometer No. 1 at ,45 inch behind the visible red colour, and No. 5 in the situation of the standard. The refracting angle of the prism was 62° 30′; and, in five minutes, the thermometer received $1\frac{1}{6}$ degrees of heat from the invisible rays. On trying the other angles, I likewise found invisible heat rays, in their usual situation beyond the red colour.

Now, setting aside a minute inquiry into the degrees of heat occasioned by these invisible rays, I shall here only consider them as an additional part, annexed to the different quantities of heat which are found to go along with the visible spectrum; in the same manner as if, in the spectrum of light, another colour had been added beyond the red. Then, as from the foregoing experiments it appears, that a change of the refracting medium, and of the angle by which the refractions were made, occasioned no alteration in the relative situation of the additional part AG,

with respect to GQ; and, as the part GQ is already known to follow the law of refraction we have mentioned, it is equally evident, that the additional heat of AG must follow the same law. We do not enter into the dispersive power of different mediums with respect to heat, since that would lead us farther than the present state of our investigation could authorise us to go; the following experiment however will shew that, as with light so with heat, such dispersive power must be admitted.

22d Experiment. Correction of the different Refrangibility of Heat, by contrary Refraction in different Mediums.

I took three prisms; one of crown glass, having an angle of 25 degrees; another of flint glass, with an angle of 24; and a third of crown glass, with an angle of 10 degrees. These being put together, as they are placed when experiments of achromatic refractions are to be made, I found that they gave a spectrum nearly without colour. The composition seemed to be rather a little over adjusted; there being a very faint tinge of red on the most refracted side, and of violet on the least refracted margin. I examined both extremes by two thermometers; keeping No. 3 as a standard, while No. 2 was applied for the discovery of invisible rays; but I found no heat on either side. After this, I placed No. 2 in the middle of the colourless illumination; and in a little time it rose two degrees, while No. 3 still remained unaltered at some small distance from the spectrum. This quantity was full as much as I could expect, considering the heat that must have been intercepted by three prisms. Thus then it appears, that the different refrangibility of heat, as well as that of light, admits of prismatic correction. And we may add, that this experiment also tends to the estab-

lishment of the contents of the preceding one; for the refrangibility of heat rays could not be thus corrected, were the sines of refraction not in a constant ratio to those of incidence.

23d Experiment. In Burning-glasses, the Focus of the Rays of Heat is different from the Focus of the Rays of Light.

I placed my burning lens, with its aperture reduced to three inches, in order to lessen the aberration arising from the spherical figure, in the united rays of the sun; and, being now apprised of the different refrangibility of the rays of heat, and knowing also that the least refrangible of them are the most efficacious, I examined the focus of light, by throwing hair-powder, with a puff, into the air. This pointed out the mean focus of the illuminating rays, situated in that part of the pencil which opticians have shewn to be the smallest space into which they can be collected. That this may be called the focus of light, our experiments, which have proved the maximum of illumination to be situated between the yellow and green, and therefore among the mean refrangible rays of light, have fully established. The mean focus being thus pointed out by the reflection of light on the floating particles of powder, I held a stick of sealing wax 1″,6, or four beats of my chronometer, in the contracted pencil, half an inch nearer to the lens than the focus. In this time, no impression was made upon the wax. I applied it now half an inch farther from the lens than that focus; and, in 8-tenths of a second, or two beats of the same chronometer, it was considerably scorched. Exposing the sealing wax also to the focus of light, the effect was equally strong in the same time; from which we may safely conclude, notwithstanding the little accuracy that can be expected, for want of a more proper

apparatus, from so coarse an experiment, that the focus of heat, in this case, was certainly farther removed from the lens than the focus of light, and probably not less than $\frac{1}{4}$ of an inch; the heat, at half an inch beyond the focus of light, being still equal to that in the focus.

ARTICLE V.—*Transmission of heat-making Rays.*

We enter now on the subject of the transmission of heat through diaphanous bodies. Our experiments have hitherto been conducted by the prism, the lens, and the mirror; these may indeed be looked upon as our principal tools, and, as such, will stand foremost in all our operations; but the scantiness of this stock cannot allow us to bring our work to perfection. Nor is it merely the want of tools, but rather the natural imperfection of those we have, that hinders our rapid progress. The prism which we use for separating the combined rays of the sun, refracts, reflects, transmits, and scatters them at the same time; and the laws by which it acts, in every one of these operations, ought to be investigated. Even the cause of the most obvious of its effects, the separation of the colours of light, is not well understood; for, in two prisms of different glass, when the angles are such as to give the same mean refraction, the dispersive power is known to differ. Their transmissions have been still less ascertained; and I need not add, that the internal and external reflexions, and the scattering of rays on every one of the surfaces, are all of such a nature as must throw some obscurity on every result of experiments made with prisms. A lens partakes of all the inconveniencies of the prism; to which its own defects of spherical aberrations must

be added. And a mirror, besides its natural incapacity of separating the rays of light from the different sorts of heat, scatters them very profusely. But, if we have been scantily provided with materials to act upon rays, it has partly been our own fault: every diaphanous body may become a new tool, in the hands of a diligent inquirer.

My apparatus for transmitting the rays of the sun is of the following construction.* In a box, 12 inches long, and 8 inches broad, are fixed two thermometers. The sides of the box are 2½ inches deep. That part of the box where the balls of the thermometers are, is covered by a board, in which are two holes of ¼ inch diameter, one over each of the balls of the thermometers; and the bottom of the box, under the cover, is cut away, so as to leave these balls freely exposed. There is a partition between the two thermometers, in that part of the box which is covered, to prevent the communication of secondary scatterings of heat. Just under the opening of the transmitting holes, on the outside of the cover, is fixed a slip of wood, on which may rest any glass or other object, of which the transmitting capacity is to be ascertained. A thin wooden cover is provided,† that it may be laid over the transmitting holes, occasionally, to exclude the rays of the sun; and, on the middle of the slip of wood, under the holes, a pin is to be stuck perpendicularly, that its shadow may point out the situation of the box with respect to the sun. The box, thus prepared, is to be fastened upon two short boards, joined together by a pair of hinges. A long slip of mahogany is screwed to the lowest of these boards, and lies in the hollow part of a long spring, fastened against the side of the upper one. The pressure of the

* See Plate XXI. Fig. 1. † See Fig. 2.

spring must be sufficiently strong to keep the boards at any angle; and the slip of mahogany long enough to permit an elevation of about 85 degrees.

In order to see whether all be properly adjusted, expose the apparatus to the sun, and lift up the board which carries the box, till the directing pin throws the shadow of its head on the place where the point is fastened. Then hold a sheet of paper under the box, and, if the thermometers have been properly placed, the shadow of their balls will be in the centre of the rays passing through the transmitting holes to the paper.

A screen of a considerable size,* with a parallelogrammic opening, should be placed at a good distance, to keep the sun's rays from every part of the apparatus, except that which is under the cover; and no more sun should be admitted into the room, than what will be completely received on the screen, interposed between the window and the apparatus.

As one of the thermometers is to indicate a certain quantity of heat coming to it by the direct ray, while the other is to shew how much of it is stopped by the glass laid over the transmitting hole, it becomes of the utmost consequence to have two thermometers of equal sensibility.† The difficulty of getting

* See Plate XXII. Fig. 1.

† The theory of the sensibility of thermometers, as far as it depends on the size of the balls, may be considered thus. Let D, *d*, S, *s*, T, *t* be the *diameters*, the points on which the *sun* acts, and the points on which the *temperature* acts, of a large and a small thermometer having spherical balls; and let $x : y$ be the intensity of the action of the sun, to the intensity of the action of the temperature, on equal points of the surface of both thermometers. Then we have $s : S :: d^2 : D^2$, and $t : T :: 4d^2 : 4D^2$. The action of the sun therefore will be expressed by $d^2 x$, $D^2 x$; and that of the temperature by $4d^2 y$, $4D^2 y$; and the united action of both by $x - 4y \times d^2$, $x - 4y \times D^2$; which are to each other, as $d^2 : D^2$. Now, the total effect being as the squares of the

such is much greater than can be imagined: a perfect equality in the size and thickness of the balls is, however, the most essential circumstance. When two are procured, they should be tried in quick and in slow exposures. These terms may be explained by referring to fire heat; for here the thermometers may be exposed so as to acquire, for instance, 30 degrees of heat in a very short time; which may then be called a quick exposure: or they may be placed so as to make it require a good while to raise them so many degrees; on which account the exposure may be called slow. It is true, that we have it not in our power to render the sun's rays more or less efficacious, and therefore cannot have a quick or slow exposure at our command; but a great difference will be found in the heat of a rising, or of a meridian sun: not to mention a variety of other causes, that influence the transmission of heat through the atmosphere. Now, when thermometers are tried in various exposures, they should traverse their scales together with constant equality; otherwise no dependance can be placed on the results drawn from experiments made with them, in cases where only a few minutes can be allowed for the action of the cause whose influence we are to investigate.

The balls must not be blacked; for, as we have already to encounter the transmitting capacity of the glass of which these balls are made, it will not be safe to add to this the transmitting disposition of one or more coats of blacking, which can never

diameters, while $x : y$ remain in their incipient ratio, and the contents of the thermometers being as the cubes, the sensible effect produced on the particles of mercury, must be as $\frac{d^3}{d^3} : \frac{D^3}{D^3} :: \frac{1}{d} : \frac{1}{D}$; that is, inversely as the diameters. The small thermometer therefore will set off with a sensibility greater than that of the large one, in the same ratio.

be brought to an equality, and are always liable to change, especially in very quick exposures.

Transmission of Solar Heat through colourless Substances.

24th Experiment.

I laid a piece of clear transparent glass, with a bluish-white cast, upon one of the holes of the transmitting machine: the faces of this glass are parallel, and highly polished. Then, putting the cover over both holes, I placed the machine in the situation where the experiment was to be made, and let it remain there a sufficient time, that the thermometers might assume a settled temperature. For this purpose, an assistant thermometer, which should always remain in the nearest convenient place to the apparatus, will be of use, to point out the time when the experiment may be begun; for this ought not to be done, till the thermometers to be used agree with the standard. In order not to lose time after an experiment, the apparatus may be taken into a cool room, or current of air, till the thermometers it contains are rather lower than the standard; after which, being brought to the required situation, they will soon be fit for action.

All these precautions having been taken, I began the experiment by first writing down the degrees of the thermometers; then, opening the cover at the time that a clock or watch shewing seconds came to a full minute, I continued to write down the state of the thermometers for not less than five minutes. The result was as follows.

	No. 5. Sun.	No. 1.
0′	67	67
1	68¼	68⅛
2	70⅛	69⅛
3	71⅜	70
4	72⅛	70⅞
5	73	71½

6 : 4½ = ,750

Here the sun communicated, in 5 minutes, 6 degrees of heat to the thermometer No. 5, which was openly exposed to its action; while, in the same time, No. 1 received only 4½ degrees by rays transmitted through the bluish-white glass: then, as 6 : 4½ : : 1 : ,750. This shews plainly, that only ¾ of the incident heat were transmitted, and therefore that ¼ of it was intercepted by the glass.

I shall here, as well as in the following experiments, point out the difference between heat and light, in order, as has been mentioned before, to lead to an elucidation of our last discussion. To effect this, therefore, I have ascertained, with all the accuracy the subject will admit of, the quantity of light transmitted through such glasses as I have used; but, as it would here interrupt the order of our subject, I have joined, at the end of this Paper, a table, with a short account of the method that has been used in making it, wherein the quantity of light transmitted is set down; and to this table I shall now refer.

To render this comparative view more clear, we may suppose always 1000 rays of heat to come from the object: then, 750 being transmitted, it follows, that the bluish-white glass used in our experiment stops 250 of them; and, by the table at

the end of this Paper, it stops 86 rays of light; the number of them coming from the object also being put equal to 1000.

It should be remarked, that when I compare the interception of solar heat with that of the light of a candle, it must not be understood that I take terrestrial to be the same as solar light; but, not having at present an opportunity of providing a similar table for the latter, I am obliged to use the former, on a supposition, that the quantity stopped by glasses may not be very different.

25*th Experiment.*

I took a piece of flint glass, about $2\frac{1}{2}$ tenths of an inch thick, and fastened it over one of the holes of the transmitting apparatus.

No. 5. Sun.	No. 1. Flint glas.
$69\frac{1}{4}$	$69\frac{1}{4}$
$71\frac{1}{4}$	71
$72\frac{2}{5}$	$72\frac{1}{4}$
$74\frac{1}{16}$	$73\frac{7}{8}$
$74\frac{7}{16}$	74
$75\frac{1}{4}$	$74\frac{3}{4} \cdots 5\frac{1}{2} : 5 = ,909$

Here the heat-making rays gave, in 5 minutes, $5\frac{1}{2}$ degrees to the thermometer No. 5; and, by transmission through the flint glass, 5 degrees to No. 1. Then, proceeding as before, we have $\frac{5}{5\frac{1}{2}} = ,909$; which shews that 91 rays of heat were stopped. In the table before referred to, we find that this glass stops 34 rays of light.

Before I proceed, it will be necessary to adopt a method of reducing the detail of my experiments into a narrower com-

pass. It will be sufficient to say, that they have all been made on the same plan as the two which have been given. The observations were always continued for at least five minutes; and, by examining the ratios of the numbers given by the thermometers in all that time, it may be seen that, setting aside little irregularities, there is a greater stoppage at first than towards the end; but, as it would not be safe to take a shorter exposure than five minutes, on account of the small quantity of heat transmitted by some glasses, I have fixed upon that interval as sufficiently accurate for giving a true comparative view. The experiments therefore may now stand abridged as follows.

26th Experiment.

I took a piece of highly polished crown glass, of a greenish colour, and, cutting it into several parts, examined the transmitting power of one of them, reserving the other pieces for some other experiments that will be mentioned hereafter.

	Sun.	Greenish crown glass.
0′	$66\frac{1}{4}$	$66\frac{1}{4}$
5	73	$71\frac{1}{4} \ldots 6\frac{1}{4} : 5 = ,741$

This glass therefore stops 259 rays of heat, and 203 of light.

27th Experiment.

I cut likewise a piece of coach glass into several parts, and tried one of them, reserving also the other pieces for future experiments.

	Sun.	Coach glass.
0′	$68\frac{7}{8}$	$68\frac{7}{8}$
5	$75\frac{7}{8}$	$74\frac{3}{8} \ldots 7 : 5\frac{1}{2} = ,786$

It stops 214 rays of heat, and 168 of light.

28th Experiment.

I examined a piece of Iceland crystal, of nearly two-tenths of an inch in thickness.

	Sun.	Iceland crystal.
0′	67	67
5	$72\frac{5}{8}$	$71\frac{1}{4}\ldots 5\frac{5}{8} : 4\frac{1}{4} = ,756$

It stops 244 rays of heat, and 150 of light.

29th Experiment.

	Sun.	Talc.
0′	$67\frac{1}{2}$	$67\frac{1}{2}$
5	72	$71\frac{3}{8}\ldots 4\frac{1}{2} : 3\frac{7}{8} = ,861$

It stops 139 rays of heat, and 90 of light.

30th Experiment.

	Sun.	An easily calcinable talc.
0′	50	50
5	$54\frac{1}{4}$	$53\frac{7}{8}\ldots 4\frac{1}{4} : 3\frac{7}{8} = ,816$

It stops 184 rays of heat, and 288 of light.

Transmission of solar Heat through Glasses of the prismatic Colours.

31st Experiment.

	Sun.	Very dark red glass.
0′	73	73
5	$79\frac{1}{4}$	$74\frac{1}{4}\ldots 6\frac{1}{4} : 1\frac{1}{4} = ,200$

This glass stops 800 rays of heat, and 9999, out of ten thousand, rays of light; which amounts nearly to a total separation of light from heat.

32d Experiment.

	Sun.	Dark-red glass.
0′	$68\frac{3}{8}$	$68\frac{3}{8}$
5	$72\frac{1}{2}$	$70 \ldots 4\frac{1}{8} : 1\frac{5}{8} = ,394$

This red glass stops only 606 rays of heat, and above 4999, out of five thousand, rays of light.

33d Experiment.

	Sun.	Orange glass.
0′	$67\frac{3}{4}$	$67\frac{3}{4}$
5	$74\frac{3}{8}$	$70\frac{3}{8} \ldots 6\frac{5}{8} : 2\frac{5}{8} = ,396$

This orange-coloured glass stops 604 rays of heat, which is nearly as much as is stopped by the last red one; but it stops only 779 rays of light.

34th Experiment.

Sun.	Yellow glass.
$70\frac{1}{2}$	$70\frac{1}{2}$
$74\frac{1}{4}$	$73 \ldots 3\frac{3}{4} : 2\frac{1}{2} = ,667$

It stops 333 rays of heat, and 319 of light.

35th Experiment.

	Sun.	Pale-green glass.
0′	$70\frac{1}{2}$	$70\frac{1}{2}$
5	$74\frac{1}{4}$	$71\frac{7}{8} \ldots 3\frac{3}{4} : 1\frac{3}{8} = ,367$

It stops 633 rays of heat, and only 535 of light.

36th Experiment.

	Sun	Dark-green glass.
0′	$67\frac{1}{2}$	$67\frac{1}{2}$
5	$74\frac{1}{8}$	$68\frac{1}{2} \ldots 6\frac{1}{8} : 1 = ,151$

This glass stops 849 rays of heat, and 949 of light. This accounts for its great use as a darkening glass for telescopes.

37th Experiment.

	Sun.	Bluish-green glass.	
0′	$69\frac{3}{8}$	$69\frac{3}{8}$	
5	$76\frac{3}{8}$	$71 \ldots 7 : 1\frac{5}{8}$	$= ,232$

It stops 768 rays of heat, and 769 of light.

38th Experiment.

	Sun.	Pale-blue glass.	
0′	$70\frac{3}{4}$	$70\frac{3}{4}$	
5	$76\frac{3}{4}$	$71\frac{7}{8} \ldots 6 : 1\frac{1}{8}$	$= ,188$

The pale blue glass stops not less than 812 rays of heat, and only 684 of light.

39th Experiment.

	Sun.	Dark-blue glass.	
0′	71	71	
5	$76\frac{7}{8}$	$74\frac{3}{4} \ldots 5\frac{7}{8} : 3\frac{3}{4}$	$= ,638$

The dark-blue glass stops only 362 rays of heat, and 801 of light.

40th Experiment.

	Sun.	Indigo glass.	
0′	$61\frac{3}{4}$	$61\frac{3}{4}$	
5	$67\frac{7}{8}$	$64 \ldots 6\frac{1}{8} : 2\frac{1}{4}$	$= ,367$

This glass stops 633 rays of heat, and 9997, out of ten thousand, rays of light.

41st Experiment.

	Sun.	Pale-indigo glass.
0′	62	62
5	$67\frac{7}{8}$	$64\frac{3}{4}\ldots 5\frac{7}{8} : 2\frac{3}{4} = ,468$

It stops 532 rays of heat, and 978 of light.

42d Experiment.

	Sun.	Purple glass.
0′	$61\frac{3}{4}$	$61\frac{3}{4}$
5	$67\frac{3}{4}$	$64\frac{1}{4}\ldots 6 : 2\frac{1}{2} = ,417$

It stops 583 rays of heat, and 993 of light.

43d Experiment.

Sun.	Violet glass.
$62\frac{1}{4}$	$62\frac{1}{4}$
$68\frac{1}{8}$	$65\frac{1}{4}\ldots 5\frac{7}{8} : 3 = ,511$

It stops 489 rays of heat, and 955 of light.

Transmission of Solar Heat through Liquids.

I took a small tube, $1\frac{1}{2}$ inch in diameter,* and fixed a stop with a hole $\frac{3}{4}$ inch wide at each end, on which a glass might be fastened, so as to confine liquids. The inner distance, or depth of the liquid, when confined, is three inches. Placing now the empty tube, with its two end glasses fixed, upon the transmitting apparatus, I had as follows:

44th Experiment.

	Sun.	Empty tube, and two glasses.
0′	53	53
5	59	$55\frac{3}{4}\ldots 6 : 2\frac{3}{4} = ,458$

* See Plate XXII. Fig. 2.

These glasses, with the intermediate air, stop 542 rays of heat, and 204 of light.

45*th Experiment.*

I filled the tube with well-water, and placed it on the transmitting apparatus.

	Sun.	Well-water.
0′	$52\frac{1}{4}$	$52\frac{1}{8}$
5	$58\frac{3}{4}$	$55 \ldots 6\frac{1}{2} : 2\frac{7}{8} = ,442$

Here two glasses, with water between them, stopped 558 rays of heat. The same glasses, and water, stop only 211 rays of light. If we were to deduct the effect of the empty machine, there would remain, for the water to stop, only 16 rays of heat, and 7 of light; but it cannot be safe to make this conclusion, as we are not sufficiently acquainted with the action of surfaces between the different mediums on the rays of heat and light; I shall therefore only notice the effect of the compound.

46*th Experiment.*

I filled now the tube with sea-water, taken from the head of the pier at Ramsgate, at high tide.

Sun.	Sea-water.
$54\frac{1}{2}$	$54\frac{1}{4}$
60	$56 \ldots 5\frac{1}{2} : 1\frac{3}{4} = ,318$

The compound stops 682 rays of heat, and 288 of light.

47*th Experiment.*

	Sun.	Spirit of wine.
0′	$51\frac{5}{8}$	$51\frac{5}{8}$
5	$57\frac{1}{4}$	$54 \ldots 6\frac{1}{8} : 2\frac{3}{8} = ,388$

The compound stops 612 rays of heat, and 224 of light.

48th Experiment.

	Sun.	Gin.	
0′	52	52	
5	$57\frac{3}{4}$	$53\frac{1}{2}$ . . . $5\frac{3}{4}$: $1\frac{1}{2}$ =	,261

This compound stops 739 rays of heat, and 626 of light.

49th Experiment.

	Sun.	Brandy.	
0′	56	56	
5	$60\frac{1}{4}$	$56\frac{7}{8}$ . . . $4\frac{1}{4}$ =	,206

This stops 794 rays of heat, and 996 rays of light.

Other liquids have also been tried; but the experiments having been attended with circumstances that demand a further investigation, they cannot now be given.

Transmission of solar Heat through scattering Substances.

50th Experiment.

I rubbed one of the pieces of crown glass, mentioned in the 26th experiment, on fine emery laid on a plain brass tool, to make the surface of it rough, which, it is well known, will occasion the transmitted light to be scattered in all directions. Supposing that it would have the same effect on heat, I tried the transmitting capacity of the glass, by exposing it with the rough side towards the sun, over one of the transmitting holes of the apparatus.

	Sun.	Crown glass; one side rubbed on emery.	
0′	67	67	
5	74	$70\frac{3}{4}$ . . . 7 : $3\frac{3}{4}$ =	,536

The glass so prepared stops 464 scattered rays of heat, and 854 of light. Now, as the same glass, in its polished state, trans-

mitted 259 rays of heat, and 203 of light, the alteration produced in the texture of its surface acts very differently upon these two principles; occasioning an additional stoppage of only 205 rays of heat, but of 651 rays of light.

51st Experiment.

One of the pieces of coach glass, mentioned in the 27th experiment, was prepared in the same manner.

	Sun.	Coach glass; one side rubbed on emery, the rough side exposed.
0′	$66\frac{1}{2}$	$66\frac{1}{2}$
5	$73\frac{1}{2}$	$69\frac{1}{2} \ldots 7 : 3 = ,429$

It stops 571 scattered rays of heat, and 885 of light; so that the fine scratches on its surface, made by the operation of emery, have again acted very differently upon the rays of heat, and of light, occasioning an additional stoppage of 375 of the former, but of no less than 717 of the latter.

52d Experiment.

I took another of the pieces of crown glass, mentioned in the 26th experiment, and rubbed both sides on emery.

	Sun.	Crown glass; both sides rubbed on emery.
0′	$69\frac{1}{2}$	$69\frac{1}{2}$
5	$75\frac{1}{2}$	$71\frac{1}{2} \ldots 6 : 2 = ,333$

The glass thus prepared, stops 667 scattered rays of heat, and 932 of light.

53d Experiment.

Another piece of coach glass, one of those that were mentioned in the 27th experiment, was prepared in the same manner.

	Sun.	Coach glass; both sides rubbed on emery.
0′	$69\frac{5}{8}$	$69\frac{5}{8}$
5	$75\frac{3}{4}$	$71\frac{1}{4} \ldots 6\frac{1}{8} : 1\frac{5}{8} = ,265$

It stops 735 scattered rays of heat, and 946 of light.

54th Experiment.

I placed now the coach glass, one side of which had been rubbed on emery, upon the transmitting hole, and over it the crown glass prepared in the same manner, both with the rough side towards the sun; but two slips of card were placed between the glasses, to keep them from touching each other.

	Sun.	{Crown glass. Coach glass.} One side of each rubbed on emery.
0′	67	67
5	$73\frac{5}{8}$	$69 \ldots 6\frac{5}{8} : 2 = ,302$

These glasses stop 698 scattered rays of heat, and 969 of light.

55th Experiment.

I placed now the coach glass, with both sides rubbed on emery, on the transmitting hole, and over it the crown glass prepared in the same manner, with two slips of card between them, to prevent a contact.

	Sun.	{Coach glass. Crown glass.} Both sides of each rubbed on emery.
0′	$69\frac{5}{8}$	$69\frac{5}{8}$
5	$75\frac{7}{8}$	$70\frac{7}{8} \ldots 6\frac{1}{4} : 1\frac{1}{4} = ,200$

These glasses stop 800 scattered rays of heat, and 979 of light.

56th Experiment.

I used now all the four glasses; placing them as follows, and putting slips of card between them, to prevent a contact.

	Sun.	Crown glass; the rough side to the sun. Coach glass; ditto. Crown glass; rough on both sides. Coach glass; ditto.
0′	$57\frac{1}{8}$	$57\frac{1}{2}$
5	$62\frac{1}{2}$	$58\frac{1}{4} \ldots 5\frac{1}{8} : \frac{1}{4} = ,146$

These four glasses stop no more than 854 scattered rays of heat, and 995 of light.

57th Experiment.

I used now a piece of glass of an olive colour, burnt into the glass, in the manner that glasses are prepared for church windows, which transmits only scattered light.

	Sun.	Olive-coloured glass.
0′	69	69
5	$76\frac{3}{4}$	$70\frac{1}{4} \ldots 7\frac{3}{4} : 1\frac{1}{4} = ,161$

This glass stops 839 scattered rays of heat, and 984 of light.

58th Experiment.

	Sun.	Calcined talc.
0′	$51\frac{3}{8}$	$51\frac{3}{8}$
5	$55\frac{1}{8}$	$51\frac{7}{8} \ldots 3\frac{3}{4} : \frac{1}{2} = ,133$

This substance stops 867 scattered rays of heat, and so much light that the sun cannot be perceived through it.*

59th Experiment.

	Sun.	White paper
0′	63	63
5	68	$63\frac{1}{4} \ldots 5 : \frac{1}{4} = ,150$

This substance stops 850 scattered rays of heat, and 994 of light.

* See the 175th Experiment.

60th Experiment.

	Sun.	Linen.
0′	68	68
5	69	$68\frac{1}{2}$ . . . 6 : $\frac{1}{2}$ = ,0833

White linen stops 916 scattered rays of heat, and 952 of light.

61st Experiment.

	Sun.	White persian.
0′	70	70
5	$76\frac{1}{4}$	$71\frac{1}{2}$ . . . $6\frac{1}{4}$: $1\frac{1}{2}$ = ,240

This thin silk stops 760 scattered rays of heat, and 916 of light.

62d Experiment.

Sun.	Black muslin.
$64\frac{3}{4}$	$64\frac{3}{4}$
70	$66\frac{1}{4}$ . . . $5\frac{1}{4}$: $1\frac{1}{2}$ = ,286

This substance stops 714 scattered rays of heat, and 737 of light.

Transmission of terrestrial Flame-heat through various Substances.

My apparatus for the purpose of transmitting flame-heat is as follows.* A box 22 inches long, $5\frac{1}{2}$ broad, and $1\frac{1}{4}$ deep, has a hole in the centre $1\frac{1}{10}$ inch in diameter, through which a wax candle, thick enough entirely to fill it, is to be put at the bottom; the box being properly elevated for the purpose. There must be two lateral holes in the bottom, 2 inches long, and $1\frac{1}{4}$ broad, one on each side of the candle, to supply it with a current of air, as otherwise it will not give a steady flame, which is absolutely necessary. At the distance of $1\frac{3}{10}$ inch from the candle, on each side, are two screens, 12 inches square, with

* See Plate XXIII. Fig 1.

a hole in each, ¼ inch in diameter, through which the heat of the candle passes to the two thermometers, which are to be placed in opposite directions, one on each side of the table. Care must be taken to place them exactly at the same distance from the centre of the flame, as otherwise they will not receive equal quantities of heat. The scales, and their supports also, must be so kept out of the way of heat coming from the candle, that they may not scatter it back on the balls, but suffer all that is not intercepted by them to pass freely forwards in the box, and downwards, through openings cut in the bottom. Before the transmitting holes, between the two wooden screens, must be two covers of the same material, close to the openings; * and it will be necessary to join those covers at the side, by a common handle, that they may be removed together, without disturbing any part of the apparatus, when the experiment is to begin.

The glasses are to be put before the thermometer, close to the transmitting hole, by placing them on a small support below, while the upper part is held close to the screen by a light plummet, suspended by a thread which is fastened on one side, and passes over the glass, to a hook on the other side.

In making experiments, many attentions are necessary, such as, keeping the candle exactly to a certain height, that the brightest part of the flame may be just in the centre of the two transmitting holes: that the wick may be always straight, and not, by bending, approach nearer to one thermometer than to the other: that the wax-cup of the candle be kept clean, and never suffered to run over, &c.

Before, and now and then between, the observations also, the thermometers must be tried a few degrees, that it may be seen

* See Fig. 2.

whether they act equally; and the candle, during the time they cool down to the temperature, must be put out by an extinguisher, large enough to rest on the bottom of the box, without touching any part of the wax. Many other precautions I need not mention, as they will soon be discovered by any one who may repeat such experiments.

63d Experiment.

	Candle.	Bluish-white glass.
0′	$59\frac{3}{8}$	$59\frac{1}{2}$
5	$62\frac{3}{8}$	$60\frac{5}{8}$ . . . 3 : $1\frac{1}{8}$ = ,375

From this experiment we find, that while the rays of the candle gave 3 degrees of heat to the thermometer openly exposed to their action, the other thermometer, which received the same rays through the medium of the interposed glass, rose only $1\frac{1}{8}$ degrees. Hence we calculate, that this glass stops 625 rays of flame-heat, out of every thousand that fall on it. It stops only 86 rays of candle-light; but this, having been referred to before, will not in future be repeated.

64th Experiment.

	Candle.	Flint glass.
0′	$59\frac{7}{8}$	$59\frac{5}{8}$
5	$62\frac{3}{8}$	$60\frac{3}{4}$ . . . $2\frac{3}{4}$: $1\frac{1}{8}$ = ,409

It stops 591 rays of flame-heat, and light as before.

65th Experiment.

	Candle.	Crown glass.
0′	$59\frac{7}{8}$	$59\frac{7}{8}$
5	$62\frac{5}{8}$	$60\frac{7}{8}$ . . . $2\frac{3}{4}$: 1 = ,364

It stops 636 rays of flame-heat.

66th Experiment.

	Candle.	Coach glass.
0′	60	$60\frac{3}{8}$
5	63	$62 \ldots 3 : 1\frac{5}{8} = ,542$

It stops 458 rays of flame-heat.

67th Experiment.

	Candle.	Iceland crystal.
0′	$58\frac{3}{4}$	$58\frac{3}{4}$
5	$62\frac{1}{8}$	$60\frac{3}{8} \ldots 3\frac{3}{8} : 1\frac{5}{8} = ,484$

It stops 516 rays of flame-heat.

68th Experiment.

	Candle.	Calcinable talc.
0′	$58\frac{7}{8}$	$58\frac{7}{8}$
5	$61\frac{7}{8}$	$60\frac{3}{4} \ldots 3 : 1\frac{7}{8} = ,625$

This substance stops only 375 rays of flame-heat.

69th Experiment.

	Candle.	Very dark red glass.
0′	$60\frac{3}{8}$	$60\frac{3}{8}$
5	$63\frac{1}{8}$	$61\frac{1}{8} \ldots 2\frac{3}{4} : 1 = ,364$

This glass stops 636 rays of flame-heat.

70th Experiment.

	Candle.	Dark red glass.
0′	$60\frac{3}{4}$	$60\frac{3}{4}$
5	$63\frac{1}{8}$	$61\frac{7}{8} \ldots 2\frac{3}{8} : 1\frac{1}{8} = ,474$

It stops 526 rays of flame-heat.

71st Experiment.

	Candle.	Orange glass.	
o′	$60\frac{1}{4}$	$60\frac{1}{4}$	
5	$63\frac{1}{8}$	$61\frac{5}{8}\ldots 3\frac{1}{8} : 1\frac{3}{8} = ,440$	

It stops 560 rays of flame-heat.

72d Experiment.

	Candle.	Yellow glass.	
o′	$60\frac{5}{8}$	$60\frac{5}{8}$	
5	$63\frac{5}{8}$	$61\frac{7}{8}\ldots 3 : 1\frac{1}{4} = ,417$	

It stops 583 rays of flame-heat.

73d Experiment.

	Candle.	Pale-green glass.	
o′	$60\frac{7}{8}$	$60\frac{7}{8}$	
5	$63\frac{7}{8}$	$62\frac{3}{8}\ldots 3 : 1\frac{1}{2} = ,500$	

It stops 500 rays of flame-heat.

74th Experiment.

	Candle.	Dark-green glass.	
o′	$61\frac{1}{8}$	$61\frac{1}{8}$	
5	64	$61\frac{7}{8}\ldots 2\frac{7}{8} : \frac{3}{4} = ,261$	

It stops 739 rays of flame-heat.

75th Experiment.

	Candle.	Bluish-green glass.	
o′	$61\frac{1}{8}$	$61\frac{1}{8}$	
5	64	$62\frac{1}{8}\ldots 2\frac{7}{8} : 1 = ,348$	

It stops 652 rays of flame-heat.

76th Experiment.

	Candle.	Pale-blue glass.	
0′	$61\frac{1}{2}$	$61\frac{1}{2}$	
5	$64\frac{3}{8}$	$62\frac{5}{8} \ldots 2\frac{7}{8} : 1\frac{1}{8}$	= ,391

It stops 609 rays of flame-heat.

77th Experiment.

	Candle.	Dark-blue glass.	
0′	$61\frac{7}{8}$	$61\frac{3}{4}$	
5	$64\frac{1}{2}$	$62\frac{3}{4} \ldots 2\frac{5}{8} : 1$	= ,381

It stops 619 rays of flame-heat.

78th Experiment.

	Candle.	Indigo glass.	
0′	$61\frac{7}{8}$	$61\frac{7}{8}$	
5	$65\frac{3}{8}$	$68 \ldots 3\frac{1}{2} : 1\frac{1}{8}$	= ,321

It stops 679 rays of flame-heat.

79th Experiment.

	Candle.	Pale indigo glass.	
0′	$62\frac{1}{8}$	$62\frac{1}{8}$	
5	$64\frac{3}{4}$	$63\frac{1}{4} \ldots 2\frac{5}{8} : 1\frac{1}{8}$	= ,429

It stops 571 rays of flame-heat.

80th Experiment.

	Candle.	Purple glass.	
0′	$61\frac{7}{8}$	$61\frac{7}{8}$	
5	65	$63\frac{3}{8} \ldots 3\frac{1}{8} : 1\frac{1}{2}$	= ,480

It stops 520 rays of flame-heat.

81*st Experiment.*

	Candle.	Violet glass.
0′	$59\frac{7}{8}$	$59\frac{7}{8}$
5	$63\frac{1}{8}$	$61\frac{1}{8} \ldots 3\frac{1}{2} : 1\frac{3}{4} = ,500$

It stops 500 rays of flame-heat.

82*d Experiment.*

	Candle.	Crown glass; one side rubbed on emery; the rough side exposed.
0′	60	60
5	$63\frac{1}{8}$	$60\frac{7}{8} \ldots 3\frac{1}{8} : \frac{7}{8} = ,259$

This glass, so prepared, stops 741 scattered rays of flame-heat.

83*d Experiment.*

	Candle.	Coach glass; one side rubbed on emery; the rough side exposed.
0′	$59\frac{1}{8}$	$59\frac{1}{8}$
5	$63\frac{1}{8}$	$60\frac{7}{8} \ldots 3\frac{3}{4} : 1\frac{1}{4} = ,333$

It stops 667 scattered rays of flame-heat.

84*th Experiment.*

	Candle.	Crown glass; both sides rubbed on emery.
0′	$59\frac{3}{4}$	$59\frac{3}{4}$
5	63	$61 \ldots 3\frac{1}{4} : 1\frac{1}{4} = ,385$

It stops 615 scattered rays of flame-heat.

85*th Experiment.*

	Candle.	Coach glass; both sides rubbed on emery.
0′	$59\frac{7}{8}$	$59\frac{3}{4}$
5	63	$60\frac{3}{4} \ldots 3\frac{1}{8} : 1 = ,820$

It stops 680 scattered rays of flame-heat.

86*th Experiment.*

	Candle.	{Crown glass. / Coach glass.} One side of each rubbed on emery.
0′	$55\frac{7}{8}$	$55\frac{7}{8}$
5	59	$56\frac{3}{4}$ . . . $3\frac{1}{8} : \frac{7}{8} = ,280$

These glasses stop 720 scattered rays of flame-heat.

87*th Experiment.*

Candle.	{Crown glass. / Coach glass.} Both sides of each rubbed on emery.
$55\frac{7}{8}$	$55\frac{7}{8}$
$59\frac{1}{4}$	57 . . . $3\frac{3}{8} : 1\frac{1}{8} = ,333$

These glasses stop 667 rays of flame-heat.

88*th Experiment.*

	Candle.	{Crown glass; the rough side to the candle. / Coach glass; ditto. / Crown glass; rough on both sides; / Coach glass; ditto.}
0′	$56\frac{3}{4}$	$56\frac{7}{8}$
5	$59\frac{5}{8}$	$57\frac{1}{4}$ . . . $2\frac{7}{8} : \frac{3}{8} = ,130$

These four glasses stop 870 scattered rays of flame-heat.

89*th Experiment.*

	Candle.	Olive-colour, burnt in glass.
0′	60	60
5	63	$60\frac{5}{8}$ . . . $3 : \frac{5}{8} = ,208$

This glass stops 792 scattered rays of flame-heat.

90*th Experiment.*

	Candle.	White paper.
0′	$57\frac{3}{8}$	$57\frac{1}{4}$
5	$60\frac{3}{8}$	$57\frac{7}{8}$ . . . $3 : \frac{5}{8} = ,208$

This substance stops 792 scattered rays of flame-heat

91st Experiment,

	Candle.	Linen.
0′	$57\frac{3}{8}$	$57\frac{3}{8}$
5	61	$58\frac{1}{2}$ . . . $3\frac{5}{8} : 1\frac{1}{8} = ,310$

It stops 690 scattered rays of flame-heat.

92d Experiment.

	Candle.	White persian.
0′	$57\frac{1}{8}$	57
5	$60\frac{1}{2}$	$58\frac{1}{8}$ . . . $3\frac{1}{8} : 1\frac{1}{8} = ,407$

It stops 593 scattered rays of flame-heat.

93d Experiment.

	Candle.	Black muslin.
0′	$57\frac{3}{4}$	$57\frac{3}{4}$
5	$60\frac{5}{8}$	59 . . . $2\frac{7}{8} : 1\frac{1}{4} = ,435$

It stops 565 scattered rays of flame-heat.

Transmission of the solar Heat which is of an equal Refrangibility with red prismatic Rays.

The apparatus which I have used for transmitting prismatic rays, is of the same construction as that which has already been described under the head of direct solar transmissions; * but here the holes in the top of the box are only two inches from each other, and no more than $\frac{1}{8}$ths in diameter.† On the face of the box are drawn two parallel lines, also $\frac{3}{8}$ths of an inch distant from each other, and inclosing the transmitting holes: they serve as a direction whereby to keep any required colour to fall equally on both holes. The distance at which the box is to be

* See Plate XXI. † See Plate XXII. Fig. 3.

placed from the prism, must be such as will allow the rays to diverge sufficiently for the required colour to fill the transmitting holes; and the balls of the thermometers placed under them ought to be less than these holes, that the projected rays may pass around them, and shew their proper adjustment. The diameters of mine, used for this purpose, are $2\frac{1}{4}$ tenths of an inch.

94*th Experiment.*

I placed my apparatus at five feet from the prism, and so as to cause the red-making rays to fall between the parallel lines, in order to find what heat-making rays would come to the thermometer along with them.

	Red rays. Therm. A.	Bluish-white glass. Therm. B.	
0′	$75\frac{5}{8}$	$75\frac{3}{8}$	
5	$77\frac{5}{8}$	$76\frac{5}{8}$	$\ldots 2 : 1\frac{1}{4} = ,625$

From this experiment it appears, that when a thousand red-making rays fall on each transmitting hole, 375 of them, if they also be the heat-making rays, are stopped by the bluish-white glass which covers one of these holes; or, what requires no other proof than the experiment itself, that 375 rays of heat, of the same refrangibility with the red rays, are intercepted by this glass.

95*th Experiment.*

Red rays.	Flint glass.	
$75\frac{3}{4}$	$75\frac{3}{8}$	
$77\frac{1}{2}$	$76\frac{7}{8}$	$\ldots 1\frac{3}{4} : 1\frac{1}{2} = ,857$

This glass stops only 143 rays of heat which are of the same refrangibility with the red rays.

96th Experiment.

	Red rays.	Crown glass.
0′	$75\frac{7}{8}$	$75\frac{5}{8}$
5	78	$77\frac{1}{8} \ldots 2\frac{1}{2} : 1\frac{1}{2} = ,706$

This glass stops 294 rays of the same sort of heat.

97th Experiment.

	Red rays.	Coach glass.
0′	$54\frac{3}{4}$	$53\frac{3}{4}$
5	$55\frac{5}{8}$	$54\frac{3}{4} \ldots 1\frac{1}{4} : 1 = ,800$

It stops 200 rays of the same sort of heat.

98th Experiment.

	Red rays.	Iceland crystal.
0′	$76\frac{1}{8}$	$75\frac{3}{4}$
5	78	$77\frac{1}{4} \ldots 1\frac{7}{8} : 1\frac{1}{2} = ,800$

This substance stops 200 rays of the same sort of heat.

99th Experiment.

	Red rays.	Calcinable talc.
0′	$51\frac{3}{4}$	$51\frac{1}{4}$
5	$53\frac{5}{8}$	$52\frac{7}{8} \ldots 1\frac{7}{8} : 1\frac{5}{8} = ,867$

It stops 133 rays of the same sort of heat.

100th Experiment.

	Red rays.	Dark-red glass.
0′	$76\frac{1}{2}$	$76\frac{1}{8}$
5	$78\frac{1}{8}$	$77\frac{1}{8} \ldots 1\frac{5}{8} : \frac{1}{2} = ,308$

This glass stops 692 rays of the same sort of heat.

101*st Experiment.*

	Red rays.	Orange glass.
0′	75	$74\frac{3}{4}$
5	77	$75\frac{3}{4}$ . . . 2 : 1 = ,500

It stops 500 rays of the same sort of heat.

102*d Experiment.*

	Red rays.	Yellow glass.
	$75\frac{3}{8}$	75
	$76\frac{7}{8}$	$75\frac{7}{8}$ . . . $1\frac{1}{2} : \frac{7}{8}$ = ,583

It stops 417 rays of the same sort of heat.

103*d Experiment.*

	Red rays.	Pale-green glass.
0′	$74\frac{1}{4}$	$74\frac{1}{8}$
5	$76\frac{3}{8}$	75 . . . $2\frac{1}{8} : \frac{7}{8}$ = ,412

It stops 588 rays of the same sort of heat.

104*th Experiment.*

	Red rays.	Dark-green glass.
0′	$68\frac{3}{4}$	$68\frac{7}{8}$
5	$70\frac{1}{2}$	$69\frac{1}{4}$ . . . $1\frac{3}{4} : \frac{3}{8}$ = ,214

It stops 786 rays of the same sort of heat.

105*th Experiment.*

	Red rays.	Bluish-green glass.
0′	69	$68\frac{7}{8}$
5	$70\frac{5}{8}$	$69\frac{3}{4}$ . . . $1\frac{5}{8} : \frac{7}{8}$ = ,538

It stops 462 rays of the same sort of heat.

106*th Experiment.*

	Red rays.	Pale-blue glass.
o′	$69\frac{5}{8}$	$69\frac{1}{2}$
5	$70\frac{7}{8}$	$69\frac{7}{8} \ldots 1\frac{1}{4} : \frac{3}{8} = ,300$

It stops 700 rays of the same sort of heat.

107*th Experiment.*

	Red rays.	Dark-blue glass.
o′	67	$67\frac{1}{4}$
5	$68\frac{3}{4}$	$68\frac{7}{8} \ldots 1\frac{3}{4} : 1\frac{5}{8} = ,929$

This glass stops only 71 rays of the same sort of heat.

108*th Experiment.*

	Red rays.	Indigo glass.
o′	$68\frac{1}{2}$	$68\frac{1}{4}$
5	$70\frac{1}{2}$	$69\frac{1}{2} \ldots 2 : 1\frac{1}{4} = ,633$

It stops 367 rays of the same sort of heat.

109*th Experiment.*

	Red rays.	Pale-indigo glass.
o′	69	$68\frac{5}{8}$
5	71	$70 \ldots 2 : 1\frac{3}{8} = ,687$

It stops 313 rays of the same sort of heat.

110*th Experiment.*

	Red rays.	Purple glass.
o′	$56\frac{1}{4}$	56
5	$58\frac{1}{2}$	$57\frac{1}{4} \ldots 2\frac{1}{4} : 1\frac{1}{4} = ,556$

It stops 444 rays of the same sort of heat.

111*th Experiment.*

	Red rays.	Violet glass.
0′	$57\frac{3}{8}$	57
5	$59\frac{1}{4}$	$58\frac{1}{8} \ldots 1\frac{7}{8} : 1\frac{1}{8} = ,600$

It stops 400 rays of the same sort of heat.

112*th Experiment.*

	Red rays.	Crown glass; one side rubbed on emery, rough side exposed.
0′	$49\frac{1}{4}$	49
5	52	$50\frac{3}{8} \ldots 2\frac{1}{4} : 1\frac{3}{8} = ,611$

This glass, so prepared, stops 389 scattered rays of the same sort of heat.

113*th Experiment.*

	Red rays.	Coach glass; one side rubbed on emery, rough side exposed.
0′	$53\frac{3}{8}$	$52\frac{7}{8}$
5	$55\frac{1}{8}$	$53\frac{3}{4} \ldots 1\frac{3}{4} : \frac{7}{8} = ,500$

It stops 500 scattered rays of the same sort of heat.

114*th Experiment.*

	Red rays.	Crown glass; both sides rubbed on emery.
0′	$50\frac{5}{8}$	$49\frac{7}{8}$
5	$52\frac{3}{4}$	$51 \ldots 2\frac{1}{8} : 1\frac{1}{8} = ,529$

It stops 471 scattered rays of the same sort of heat.

115*th Experiment.*

	Red rays.	Coach glass; both sides rubbed on emery.
0′	$54\frac{1}{8}$	$53\frac{3}{4}$
5	$55\frac{5}{8}$	$54 \ldots 1\frac{1}{2} : \frac{1}{4} = ,167$

It stops 833 scattered rays of the same sort of heat.

116th Experiment.

	Red rays.	Calcined talc.
0′	$51\frac{1}{8}$	$50\frac{1}{2}$
5	$53\frac{1}{2}$	$51\frac{1}{8}\ldots 2\frac{3}{8} : \frac{5}{8} = ,263$

This substance stops 737 scattered rays of the same sort of heat.

Transmission of Fire-Heat through various Substances.

When the same fire is to give an equal heat to two thermometers, at some short distance from each other, it becomes highly necessary that there should be a place of considerable dimensions in its centre, where it may burn with an equal glow, and without flame or smoke. To obtain this, I used a grate 19 inches broad, and $8\frac{3}{4}$ high, having only three bars, which divide the fire into three large openings. In the centre of the middle one of these, when the grate is well filled with large coals or coke, we may, with proper management, keep up the required equality of radiance.

The apparatus I have used is of the following construction.* A screen of wood, 3 feet 6 inches high, and 3 feet broad, lined towards the fire with plates of iron, has two holes, $\frac{3}{4}$ of an inch in diameter, and at the distance of $2\frac{1}{2}$ inches from each other, one on each side of the middle of the screen, and of a height that will answer to the centre of the fire. $2\frac{1}{4}$ inches under the centre of the holes is a shelf, about 22 inches long and 4 broad, on which are placed two thermometers, in opposite directions, fixed on proper stands, to bring the balls, quite disengaged from the scales, directly 2 inches behind the transmitting

* See Plate XXIV.

holes. A small thin wooden partition is run up between the thermometers, to prevent the heat transmitted through one hole from coming to the thermometer belonging to the other.

The screen is fixed upon a light frame, which fits exactly into the opening of the front of the marble chimney-piece; and the ends of the frame are of a length which, when the screen is placed before the fire, will just bring the transmitting holes to be $6\frac{1}{2}$ inches from the front bars of the grate.

A large wooden cover, also plated with iron, shuts up the transmitting holes on the side next to the fire; but may be drawn up by a string on the outside, so as to open them when required.

Two assistant thermometers are placed on proper stands, to bring their balls to the same distance from the screen as those which receive the heat of the fire; but removed sideways as far as necessary, to put them out of the reach of any rays that pass obliquely through the transmitting holes. They are to indicate any change of temperature that may take place during the time of the experiment: for, notwithstanding the largeness of the screen, some heat will find its way round and over it; and this acting as a general cause, its effect must be allowed for.

117*th Experiment.*

Having tried the apparatus sufficiently to find that the thermometers exposed to the transmitting holes would generally receive 20 or more degrees of heat, without differing more than sometimes $\frac{1}{8}$ or at most $\frac{1}{4}$ of a degree, I now placed the bluish-white glass of the 24th experiment upon a support prepared for the purpose, so as closely to cover one of the transmitting holes. A small spring, moveable on its centre, is always turned against

the upper part of the transmitting glasses, to keep them in their situation.

	Fire.	Bluish-white glass.
0′	66	66
5	86	71 . . . 20 : 5 = ,250

This glass stops 750 rays of fire-heat. By looking through it, at the same place in the fire, after the screen was removed, in order to cool the apparatus for the next experiment, I found that this glass can hardly be said to stop any of the light of the fire.

118th Experiment.

	Fire.	Flint glass.
0′	67	67
5	87	72 . . . 20 : 5 = ,250

It stops 750 rays of fire-heat.

119th Experiment.

	Fire.	Crown glass.
0′	67	67
5	$86\frac{3}{4}$	$72\frac{1}{2}$ . . . $19\frac{3}{4} : 5\frac{1}{2}$ = ,278

It stops 722 rays of fire-heat.

120th Experiment.

	Fire.	Coach glass.
0′	$67\frac{1}{2}$	$67\frac{1}{2}$
5	$86\frac{3}{4}$	73 . . . $19\frac{1}{4} : 5\frac{1}{2}$ = ,286

It stops 714 rays of fire-heat.

121st Experiment.

	Fire.	Iceland crystal.
0′	68	68
5	$90\frac{1}{2}$	$73\frac{1}{2}$ . . . $22\frac{1}{2} : 5\frac{1}{2}$ = ,244

This substance stops 756 rays of fire-heat.

122*d Experiment.*

I took now the piece of talc used in the 30th experiment, and, placing it over the transmitting hole, I had the following result. But, as the unexpected event of a calcination, which took place, was attended with circumstances that ought to be noticed, I shall, instead of the usual abridgment of the experiments, give this at full length.

	Fire. Therm. D.	Talc. Therm. C.	
o′	65	65	
1	72	67 . . . . . 7 : 2	= ,289
2	77	68¼ . . . 12 : 3⅜	= ,281
3	80½	69½ . . . 15½ : 4½	= ,290
4	83	70 . . . . 18 : 5	= ,278
5	85	70¼ . . . 20 : 5¼	= ,287

This substance stops 713 rays of fire-heat.

I am now to point out the singularity of this experiment; which consists, as we may see by the above register of it, in the apparently regular continuance of its power of transmitting heat, while its capacity of transmitting light was totally destroyed. For, when I placed this piece of talc over the hole in the screen, it was extremely transparent, as this substance is generally known to be; and yet, when the experiment was over, it appeared of a beautiful white colour; and its power of transmitting light was so totally destroyed, that even the sun in the meridian could not be perceived through it. Now, had the power of transmitting heat through this substance been really uniform during all the five minutes, it would have been quite a new phænomenon; as all my experiments are attended with a regular increase

of it; but since, by calcination, the talc lost much of its transmitting power, we may easily account for this unexpected regularity.

123d Experiment.

	Fire.	Very dark red glass.
	66	66
	$89\frac{1}{4}$	75 ... $23\frac{1}{4} : 9 = ,387$

This glass stops 613 rays of fire-heat.

124th Experiment.

	Fire.	Dark-red glass.
0′	67	67
5	$92\frac{3}{4}$	78 ... $25\frac{3}{4} : 11 = ,427$

This glass, which stops 999,8 rays of candle-light, stops only 573 rays of fire-heat; whereas my piece of thick flint glass, which stops no more than 91 rays of that light, stops no less than 750 of fire-heat. It does not appear, by looking through these glasses, that there is a difference in their disposition to transmit candle-light or fire-light.

125th Experiment.

	Fire.	Orange glass.
0′	66	66
5	80	71 ... $14 : 5 = ,357$

It stops 643 rays of fire-heat.

126th Experiment.

	Fire.	Yellow glass.
0′	$61\frac{1}{4}$	$61\frac{1}{4}$
5	83	$68\frac{7}{8}$ ... $21 : 7\frac{7}{8}$. cor. $-1\frac{1}{8}$. $20\frac{5}{8} : 6\frac{1}{3} = ,315$

This experiment being made early in the morning, before the temperature of the room was come to its usual height, the assistant thermometers shewed a gradual rising of $1\frac{1}{8}$ degree in the 5 minutes: they are in general very steady. The glass stops 685 rays of fire-heat.

127*th Experiment.*

	Fire.	Pale-green glass.
0′	$65\frac{3}{4}$	$65\frac{3}{4}$
5	85	$71\frac{3}{4}\ldots 19\frac{1}{4} : 6 = ,312$

It stops 688 rays of fire-heat.

128*th Experiment.*

	Fire.	Dark-green glass.
0′	68	68
5	$88\frac{1}{4}$	$73\frac{3}{8}\ldots 20\frac{3}{8} : 5\frac{3}{4}$ cor. $-\frac{1}{4}^{\circ} = ,255$

It stops 745 rays of fire-heat.

129*th Experiment.*

	Fire.	Bluish-green glass.
0′	$68\frac{1}{2}$	$68\frac{1}{2}$
5	87	$74\frac{1}{8}\ldots 18\frac{1}{2} : 5\frac{5}{8} = ,304$

It stops 696 rays of fire-heat.

130*th Experiment.*

	Fire.	Pale-blue glass.
0′	$68\frac{1}{2}$	68
5	$86\frac{1}{4}$	$78\frac{3}{4}\ldots 17\frac{3}{4} : 5\frac{3}{4} = ,824$

It stops 676 rays of fire-heat.

131*st Experiment.*

	Fire.	Dark-blue glass.	
0′	67	67	
5	$84\frac{7}{8}$	73 ... $17\frac{7}{8}$: 6 . cor. -1° =	,296

It stops 704 rays of fire-heat.

132*d Experiment.*

	Fire.	Indigo glass.	
0′	$69\frac{1}{4}$	$69\frac{1}{4}$	
5	$85\frac{3}{8}$	$73\frac{3}{4}$ ... $16\frac{1}{8}$: $4\frac{1}{2}$ =	,279

It stops 721 rays of fire-heat.

133*d Experiment.*

	Fire.	Pale indigo glass.	
0′	$67\frac{1}{2}$	$67\frac{1}{2}$	
5	$85\frac{7}{8}$	74 ... $18\frac{1}{8}$: $6\frac{1}{2}$. cor. $-\frac{1}{4}^{\circ}$ =	,345

It stops 655 rays of fire-heat.

134*th Experiment.*

	Fire.	Purple glass.	
0′	69	69	
5	83	$73\frac{1}{2}$ ... 14 : $4\frac{1}{2}$ =	,321

It stops 679 rays of fire-heat.

135*th Experiment.*

	Fire.	Violet glass.	
0′	$66\frac{1}{2}$	$66\frac{1}{2}$	
5	$86\frac{1}{2}$	$74\frac{1}{4}$ ... 20 : $7\frac{3}{4}$ =	,385

It stops 615 rays of fire-heat,

136*th Experiment.*

	Fire.	Crown glass; one side rubbed on emery.
0′	$67\frac{5}{8}$	$67\frac{5}{8}$
5	$89\frac{3}{4}$	$73\frac{3}{4}$ . . . $22\frac{1}{8} : 6\frac{1}{8} = ,277$

This glass, so prepared, stops 723 scattered rays of fire-heat.

137*th Experiment.*

	Fire.	Coach glass; one side rubbed on emery.
0′	68	$67\frac{1}{2}$
5	$87\frac{1}{8}$	$72\frac{1}{2}$ . . . $19\frac{1}{8} : 4\frac{5}{16} = ,242$

It stops 758 scattered rays of fire-heat.

138*th Experiment.*

	Fire.	Crown glass; both sides rubbed on emery.
0′	$68\frac{1}{2}$	68
5	$92\frac{1}{8}$	73 . . . $23\frac{7}{8} : 5 = ,209$

It stops 791 scattered rays of fire-heat.

139*th Experiment.*

	Fire.	Coach glass; both sides rubbed on emery.
0′	67	67
5	88	$70\frac{1}{2}$ . . . 21 : $3\frac{1}{2}$. cor. $-\frac{1}{2}^{\circ} = ,146$

It stops 854 scattered rays of fire-heat.

140*th Experiment.*

	Fire.	{ Crown glass. / Coach glass. } One side of each rubbed on emery.
0′	66	66
5	86	$69\frac{7}{8}$ . . . 20 : $3\frac{7}{8}$. cor. $-1^{\circ} = ,151$

These glasses stop 849 scattered rays of fire-heat.

141*st Experiment.*

	Fire.	{Crown glass. / Coach glass.} Both sides of each rubbed on emery.
o′	$66\frac{3}{4}$	$66\frac{3}{4}$
5	$89\frac{3}{4}$	$68\frac{1}{2}$ . . . 17 : $1\frac{3}{4}$ = ,103

These glasses stop 897 scattered rays of fire-heat.

142*d Experiment.*

	Fire.	The four glasses of the two preceding experiments put together.
o′	66	66
5	80	$67\frac{3}{8}$ . . . 14 : $1\frac{3}{4}$ = ,098

These four glasses stop 902 scattered rays of fire-heat.

143*d Experiment.*

	Fire.	Olive colour, burnt into glass.
o′	$63\frac{3}{4}$	$63\frac{3}{4}$
5	$85\frac{3}{4}$	$67\frac{1}{2}$ . . . 22 : $3\frac{3}{4}$. cor. $-\frac{1}{2}^{\circ}$ = ,151

This glass stops 849 scattered rays of fire-heat.

144*th Experiment.*

	Fire.	Paper.
o′	$66\frac{1}{2}$	$66\frac{1}{2}$
5	$83\frac{1}{2}$	68 . . . 17 : $1\frac{1}{2}$ = ,0882

This substance stops 912 scattered rays of fire-heat; it was turned a little yellow by the exposure.

145*th Experiment.*

	Fire.	Linen.
o′	$63\frac{3}{4}$	$63\frac{3}{4}$
5	$84\frac{1}{4}$	67 . . . 21 : $3\frac{1}{4}$. cor. $-1\frac{1}{2}^{\circ}$ = ,0897

This substance stops 910 scattered rays of fire-heat.

146*th Experiment.*

	Fire.	White persian.
0′	$65\frac{1}{4}$	$65\frac{3}{4}$
5	$81\frac{1}{8}$	$68\frac{3}{8}$ . . . $15\frac{3}{8} : 2\frac{5}{8} = ,171$

This substance stops 829 scattered rays of fire-heat.

147*th Experiment.*

	Fire.	Black muslin.
0′	66	66
5	$82\frac{1}{2}$	$70\frac{1}{2}$ . . . $16\frac{1}{2} : 4\frac{1}{2}$. cor. $+ \frac{1}{2}° = ,294$

This substance stops 706 scattered rays of fire-heat.

Transmission of the invisible Rays of solar Heat.

The same apparatus which I have used for the transmission of coloured prismatic rays,* will also do for the invisible part of the heat spectrum: it is only required to add two or three more parallel lines, one-tenth of an inch from each other, below the two which inclose the transmitting holes, in order to use them for directing the invisible rays of heat, by the position of the visible rays of light, to fall on the place required for coming to the thermometers.

148*th Experiment.*

	Invisible rays.	Bluish-white glass.
0′	48	47
5	$49\frac{3}{4}$	$48\frac{5}{8}$ . . . $1\frac{3}{4} : 1\frac{5}{8} = ,929$

This glass stops only 71 invisible rays of heat.

* See Plate XXII. Fig. 3.

149th Experiment.

	Invisible rays.	Flint glass.
0′	$50\frac{3}{4}$	$49\frac{7}{8}$
5	52	$51\frac{1}{8} \ldots 1\frac{1}{4} : 1\frac{1}{4} = 1{,}000$

This glass stops no invisible rays of heat.

150th Experiment.

	Invisible rays.	Crown glass.
0′	$50\frac{1}{2}$	$49\frac{3}{4}$
5	$51\frac{7}{8}$	$50\frac{7}{8} \ldots 1\frac{3}{8} : 1\frac{1}{8} = ,818$

It stops 182 invisible rays of heat.

151st Experiment.

	Invisible rays.	Coach glass.
	$54\frac{1}{2}$	$53\frac{7}{8}$
	$55\frac{3}{8}$	$54\frac{5}{8} \ldots \frac{7}{8} : \frac{3}{4} = ,857$

It stops 143 invisible rays of heat.

152d Experiment.

	Invisible rays.	Calcinable talc.
0′	$51\frac{3}{8}$	$50\frac{3}{4}$
5	$52\frac{7}{8}$	$51\frac{7}{8} \ldots 1\frac{1}{2} : 1\frac{1}{8} = ,750$

This substance stops 250 invisible rays of heat.

153d Experiment.

	Invisible rays.	Dark-red glass.
0′	$47\frac{5}{8}$	$46\frac{3}{4}$
5	$48\frac{5}{8}$	$47\frac{3}{4} \ldots 1 : 1 = 1{,}000$

This glass stops no invisible rays of heat. This accounts for the strong sensation of heat felt by the eye, in looking at

the sun through a telescope, when red darkening glasses are used.

154*th Experiment.*

	Invisible rays.	Orange glass.
0′	$51\frac{5}{8}$	51
5	53	$52 \ldots 1\frac{3}{8} : 1 = ,727$

It stops 273 invisible rays of heat.

155*th Experiment.*

	Invisible rays.	Yellow glass.
0′	$51\frac{3}{4}$	51
5	53	$52 \ldots 1\frac{1}{4} : 1 = ,800$

It stops 200 invisible rays of heat.

156*th Experiment.*

	Invisible rays.	Pale-green glass.
0′	$51\frac{7}{8}$	$51\frac{1}{4}$
5	$52\frac{7}{8}$	$51\frac{7}{8} \ldots 1 : \frac{5}{8} = ,625$

It stops 375 invisible rays of heat.

157*th Experiment.*

	Invisible rays.	Dark-green glass.
0′	$51\frac{7}{8}$	$51\frac{1}{2}$
5	$52\frac{7}{8}$	$52 \ldots 1 : \frac{1}{2} = ,500$

It stops 500 invisible rays of heat.

158*th Experiment.*

	Invisible rays.	Bluish-green glass.
0′	53	$52\frac{1}{4}$
5	$54\frac{1}{4}$	$52\frac{1}{2} \ldots 1\frac{1}{4} : \frac{1}{4} = ,200$

It stops 800 invisible rays of heat.

159*th Experiment.*

	Invisible rays.	Pale-blue glass.
0′	$51\frac{7}{8}$	$51\frac{1}{4}$
5	$53\frac{3}{8}$	$51\frac{7}{8} \ldots 1\frac{1}{2} : \frac{5}{8} = ,417$

It stops 583 invisible rays of heat.

160*th Experiment.*

	Invisible rays.	Dark-blue glass.
0′	$52\frac{7}{8}$	$51\frac{5}{8}$
5	$52\frac{7}{8}$	$52\frac{1}{4} \ldots \frac{3}{4} : \frac{5}{8} = ,833$

It stops 167 invisible rays of heat.

161*st Experiment.*

	Invisible rays.	Indigo glass.
0′	$52\frac{7}{8}$	$52\frac{1}{4}$
5	$54\frac{3}{8}$	$53 \ldots 1\frac{1}{2} : \frac{3}{4} = ,500$

It stops 500 invisible rays of heat.

162*d Experiment.*

	Invisible rays.	Pale-indigo glass.
0′	$52\frac{3}{4}$	$52\frac{1}{8}$
5	$53\frac{1}{4}$	$52\frac{7}{8} \ldots 1 : \frac{3}{4} = ,750$

It stops 250 invisible rays of heat.

163*d Experiment.*

	Invisible rays.	Purple glass.
0′	$51\frac{1}{4}$	$50\frac{3}{8}$
5	$52\frac{5}{8}$	$51\frac{3}{8} \ldots 1\frac{3}{8} : 1 = ,727$

It stops 273 invisible rays of heat.

164*th Experiment.*

	Invisible rays.	Violet glass.
o′	$59\frac{1}{4}$	$52\frac{3}{8}$
5	$54\frac{1}{4}$	$53\frac{1}{8} \ldots 1 : \frac{3}{4} = ,750$

It stops 250 invisible rays of heat.

165*th Experiment.*

	Invisible rays.	Crown glass; one side rubbed on emery, rough side exposed.
o′	$49\frac{1}{2}$	$48\frac{3}{4}$
5	$50\frac{3}{4}$	$49\frac{1}{4} \ldots 1\frac{1}{4} : \frac{1}{2} = ,400$

This glass, so prepared, stops 600 scattered invisible rays of heat.

166*th Experiment.*

	Invisible rays.	Coach glass; one side rubbed on emery, rough side exposed.
o′	54	$53\frac{1}{8}$
5	$55\frac{1}{4}$	$54 \ldots 1\frac{1}{4} : \frac{5}{8} = ,500$

It stops 500 scattered invisible rays of heat.

167*th Experiment.*

	Invisible rays.	Crown glass; both sides rubbed on emery.
o′	50	$49\frac{1}{8}$
5	$51\frac{1}{4}$	$49\frac{5}{8} \ldots 1\frac{1}{4} : \frac{1}{2} = ,400$

It stops 600 scattered invisible rays of heat.

168*th Experiment.*

	Invisible rays.	Coach glass; both sides rubbed on emery.
o′	$54\frac{1}{4}$	$54\frac{1}{8}$
5	$55\frac{5}{8}$	$54\frac{1}{8} \ldots \frac{7}{8} : \frac{1}{4} = ,286$

It stops 714 scattered invisible rays of heat.

169th Experiment.

	Invisible rays.	Calcined talc.
0′	$51\frac{7}{8}$	$50\frac{7}{8}$
5	53	$51 \ldots 1\frac{1}{8} : \frac{1}{8} = ,111$

This substance stops 889 scattered invisible rays of heat.

Transmission of invisible terrestrial Heat.

This is perhaps the most extensive and most interesting of all the articles we have to investigate. Dark heat is with us the most common of all; and its passage from one body into another, is what it highly concerns us to trace out. The slightest change of temperature denotes the motion of invisible heat; and if we could be fully informed about the method of its transmission, much light would be thrown on what now still remains a mysterious subject. It must be remembered, that in the following experiments, I only mean to point out the transmission of such dark heat as I have before proved to consist of rays, without inquiring whether there be any other than such existing.

My apparatus for these experiments is as follows.* A box 12 inches long, $5\frac{1}{2}$ broad, and 3 deep, has a partition throughout its whole length, which divides it into two parts. At one end of each division is a hole $\frac{3}{4}$ inch in diameter; and each division contains a thermometer, with its ball exposed to the hole, and at one inch distance from the outside of the box. Four inches of the box, next to the holes, are covered; the rest is open. In the front of it is a narrow slip of wood, on which may rest any glass to be tried; and it is held close to the wood at the top, by a small spring applied against it. Two screws are planted upon the front, one on each side, which may be

* See Plate XXV. Fig. 1.

drawn out or screwed in, by way of accurately adjusting the distance of the thermometer from the line of action.

In order to procure invisible terrestrial heat, I have tried many different ways, but a stove is the most commodious of them. Iron is a substance that transmits invisible heat very readily; while, at the same time, it will most effectually intercept every visible ray of the fire by which it is heated, provided that be not carried to any great excess. I therefore made use of an iron stove,* having four flat sides, and being constructed so as to exclude all appearance of light. I had it placed close to a wall, that the pipe which conveys away smoke might not scatter heat into the room.

The thermometer box, when experiments are to be made, is to be put into an arrangement of twelve bricks, placed on a stand, with casters: † these bricks, when the stand is rolled close to the stove, which must not be done till an experiment is to begin, form an inclosure, just fitting round the sides, bottom, and covered part of the top of the thermometer box, and completely guard it against the heat of the stove. The box is then shoved into the brick opening, close to the iron side of the stove, where the two front screws, coming into contact with the iron plate, give the thermometers their proper distance; which, in the following experiments, has been such as to bring the most advanced part of the balls to one inch and four-tenths from the hot iron.

It will be necessary to remark, that on calculating the transmissions for the fifth minute, I found that it would not be doing justice to the stopping power of the glasses, to take so long a time; for, notwithstanding the use of brickwork, and the

* See Plate XXV. Fig. 2. † See Fig. 3.

precaution I had taken, of having two sets of it, that one might be cooling while the other was employed, and though neither of them was ever very hot, yet I found that so much heat came to the box, that when it was taken out of the bricks, in order to be cooled, the thermometers continued still to rise, at an average, about two degrees higher than they were. I have therefore now taken the third minute, as a much safer way to come at the truth.

170th Experiment.

	Stove.	Bluish-white glass.
0′	56	$55\frac{3}{4}$
3	$59\frac{3}{4}$	$56\frac{7}{8}$ . . . $3\frac{1}{4} : 1\frac{1}{8} = ,800$

This glass stops 700 invisible rays of heat.

171st Experiment.

	Stove.	Flint glass.
0′	$53\frac{3}{4}$	$53\frac{1}{2}$
3	$55\frac{5}{8}$	$54\frac{3}{8}$ . . . $1\frac{7}{8} : \frac{7}{8} = ,467$

It stops 533 invisible rays of heat.

172d Experiment.

	Stove.	Crown glass.
0′	$50\frac{1}{2}$	$50\frac{1}{2}$
3	$53\frac{3}{8}$	$51\frac{1}{8}$ . . . $2\frac{7}{8} : \frac{5}{8} = ,217$

It stops 783 invisible rays of heat.

173d Experiment.

	Stove.	Coach glass.
0′	$50\frac{1}{2}$	$50\frac{1}{2}$
3	$52\frac{1}{2}$	$51\frac{1}{4}$ . . . $2 : \frac{1}{4} = ,375$

It stops 625 invisible rays of heat.

174*th Experiment.*

	Stove.	Iceland crystal.
o′	47	$46\frac{1}{2}$
3	$54\frac{3}{4}$	$48\frac{5}{8}\ldots 7\frac{1}{2} : 2\frac{1}{8} = ,274$

This substance stops 726 invisible rays of heat.

175*th Experiment.*

	Stove.	Calcinable talc.
o′	51	$51\frac{5}{8}$
3	$57\frac{1}{2}$	$54\frac{1}{4}\ldots 6\frac{1}{2} : 2\frac{5}{8} = ,404$

At the end of five minutes, when the box was taken out of the bricks, the talc was perfectly turned into a scattering substance: as such, it stops 596 scattered invisible rays of heat. The sun cannot be seen through it; but this I find is chiefly owing to its scattering disposition. It stops however 997 scattered rays of light.

176*th Experiment.*

	Stove.	Dark red glass.
o′	58	58
3	$64\frac{1}{4}$	$60\frac{1}{2}\ldots 6\frac{1}{4} : 2\frac{1}{2} = ,370$

This glass stops 630 invisible rays of heat.

177*th Experiment.*

	Stove.	Orange glass.
o′	$55\frac{1}{2}$	$55\frac{1}{4}$
3	$60\frac{3}{4}$	$57\frac{3}{4}\ldots 5\frac{1}{4} : 2\frac{1}{2} = ,476$

It stops 524 invisible rays of heat.

178*th Experiment.*

	Stove.	Yellow glass.
0′	$57\frac{3}{4}$	$57\frac{1}{4}$
3	$61\frac{3}{4}$	$59\frac{3}{8} \cdots 4 : 2\frac{1}{8} = ,531$

It stops 469 invisible rays of heat.

179*th Experiment.*

	Stove.	Pale-green glass.
0′	$51\frac{1}{2}$	$51\frac{1}{2}$
3	$56\frac{1}{4}$	$53\frac{1}{4} \cdots 4\frac{1}{4} : 1\frac{1}{4} = ,368$

It stops 632 invisible rays of heat.

180*th Experiment.*

	Stove.	Dark-green glass.
0′	50	$49\frac{1}{2}$
3	$53\frac{3}{4}$	$50\frac{5}{8} \cdots 3\frac{3}{4} : 1\frac{1}{8} = ,300$

It stops 700 invisible rays of heat.

181*st Experiment.*

	Stove.	Bluish-green glass.
0′	51	51
3	$55\frac{1}{2}$	$53 \cdots 4\frac{1}{2} : 2 = ,444$

It stops 556 invisible rays of heat.

182*d Experiment.*

	Stove.	Pale-blue glass.
	$53\frac{3}{4}$	$53\frac{6}{8}$
	$57\frac{5}{8}$	$55\frac{3}{8} \cdots 3\frac{7}{8} : 1\frac{1}{4} = ,452$

It stops 548 invisible rays of heat.

183*d Experiment.*

	Stove.	Dark-blue glass.
0′	$58\frac{1}{2}$	53
8	$55\frac{7}{8}$	$53\frac{7}{8}$ . . . $2\frac{1}{8} : \frac{7}{8} = ,368$

It stops 632 invisible rays of heat.

184*th Experiment.*

	Stove.	Indigo glass.
0′	$54\frac{1}{8}$	54
8	$59\frac{5}{8}$	$55\frac{7}{8}$ . . . $5\frac{1}{2} : 1\frac{7}{8} = ,341$

It stops 659 invisible rays of heat.

185*th Experiment.*

	Stove.	Pale indigo glass.
0′	$53\frac{1}{2}$	$53\frac{1}{2}$
8	$59\frac{3}{4}$	$55\frac{3}{8}$ . . . $6\frac{1}{4} : 1\frac{7}{8} = ,300$

It stops 700 invisible rays of heat.

186*th Experiment.*

	Stove.	Purple glass.
0′	$51\frac{3}{4}$	$51\frac{1}{8}$
8	$56\frac{1}{8}$	$52\frac{3}{8}$ . . . $4\frac{5}{8} : 1\frac{1}{4} = ,270$

It stops 730 invisible rays of heat.

187*th Experiment.*

	Stove.	Violet glass.
0′	51	$51\frac{1}{2}$
8	$55\frac{3}{4}$	53 . . . $4\frac{1}{4} : 1\frac{1}{2} = ,316$

It stops 684 invisible rays of heat.

188*th Experiment.*

	Stove.	Crown glass; one side rubbed on emery.
0′	$49\frac{1}{4}$	$49\frac{1}{4}$
3	$54\frac{1}{4}$	$50\frac{3}{8} \ldots 5 : 1\frac{1}{8} = ,225$

This glass, so prepared, stops 775 invisible rays of scattered heat.

189*th Experiment.*

	Stove.	Coach glass; one side rubbed on emery,
0′	50	50
3	$57\frac{1}{4}$	$51\frac{7}{8} \ldots 7\frac{1}{4} : 1\frac{7}{8} = ,259$

It stops 741 invisible rays of scattered heat.

190*th Experiment.*

	Stove.	Crown glass; both sides rubbed on emery.
0′	52	52
3	58	$53 \ldots 6 : 1 = ,167$

It stops 833 invisible rays of scattered heat.

191*st Experiment.*

	Stove.	Coach glass; both sides rubbed on emery.
0′	52	52
3	$55\frac{1}{4}$	$52\frac{3}{4} \ldots 3\frac{1}{4} : \frac{3}{4} = ,231$

It stops 769 invisible rays of scattered heat.

192*d Experiment.*

	Stove.	Olive colour, burnt in glass.
0′	$51\frac{1}{2}$	$51\frac{1}{2}$
3	57	$53\frac{1}{2} \ldots 5\frac{1}{2} : 2 = ,364$

It stops 636 invisible rays of scattered heat.

193*d Experiment.*

	Stove.	White paper.	
o′	52	52	
3	$57\frac{1}{8}$	$54\frac{1}{2} \cdots 5\frac{1}{8} : 2\frac{1}{2}$	= ,465

This substance stops only 535 invisible rays of scattered heat.

194*th Experiment.*

	Stove.	Linen.	
o′	$53\frac{3}{8}$	$53\frac{1}{8}$	
3	$57\frac{3}{4}$	$55\frac{1}{4} \cdots 4\frac{3}{8} : 2\frac{3}{8}$	= ,543

It stops 457 invisible rays of scattered heat.

Article vi.—*Scattering of Solar Heat.*

We are now come to a branch of our inquiry which, from its novelty, would deserve a fuller investigation than we can at present enter into. The scattering of heat, is a reflection of it on the rough surfaces of bodies: it is therefore a principle of general influence, since all bodies, even the most polished, are sufficiently rough to scatter heat in all directions. In order, therefore, to compare the effect of rough surfaces on heat with their effect on light, I have made a number of experiments, from which the following are selected, for the purpose of our intended comparative view.

The apparatus I have used for scattering solar heat, is like that which served for transmissions;* but here the holes through which the sun's rays enter,† are very exactly $1\frac{1}{2}$ inch in diameter each; and are chamferred away on the under side,

* See Plate XXI. Fig. 1. † See Plate XXII. Fig. 4.

that no re-scattering may take place in the thickness of the covering board: the distance of the centre of the holes is 4 inches. A little more than an inch below, and under the centre of the holes, are the balls of the small thermometers A and B, well shaded from the direct rays of the sun, by small slips of wood, of the shape of the ball, and of that part of the stem which is exposed.

Under each thermometer is a small tablet,* on which the objects intended for scattering the sun's rays are to be placed. The tablets are contrived so as to bring the objects perpendicularly under the openings, and under the centre of the balls of the thermometers, at the distance of exactly one inch from them. Every thing being thus alike on both sides of the box, it is evident, from the equality of the holes, that an equal number of solar rays will fall on each object, and will by them be scattered back on the thermometers, at equal angles, and equal distances.

The first five experiments that follow, were made with an apparatus somewhat different from the one here described; and, though the result of them may not be so accurate as if they had been made with the present one, I must give them as they are, since time will not allow of a repetition.

195*th Experiment.*

	Sun.	Message card scattering.
o′	64	64
5	$69\frac{1}{4}$	$66\frac{1}{8}\ldots 5\frac{1}{4} : 2\frac{1}{8} = ,413$

Here an object of a white colour, 3,6 inches long, and 2,6 broad, scattered, in 5 minutes, 413 rays of heat back upon one

* See Plate XXII. Fig. 3.

thermometer, while the other received a thousand, directly from the sun. Now, in order the better to compare the proportion of light and heat scattered by different objects, we shall put these 413 rays equal to 1000; or, which is nearly the same, multiply them by 2,421. Then, since the message card also scatters 1000 rays of light, as will be found in a table at the end of the transmission table, our present object may be made a standard for a comparison with the four following ones.

196*th Experiment.*

	Sun.	Pink-coloured paper scattering.
0′	64	64
5	70	$66\frac{1}{8}\ldots 6 : 2\frac{1}{8} = ,438$

Here a piece of pink-coloured paper, of the same dimensions with the card of the last experiment, and placed in the same situation, scattered, as we find by the same mode of multiplication, 1060 rays of heat; and, by our table, it scatters 513 of light.

197*th Experiment.*

	Sun.	Pale-green paper scattering.
0′	$64\frac{1}{8}$	$64\frac{1}{8}$
5	$69\frac{7}{8}$	$66\frac{1}{4}\ldots 5\frac{3}{4} : 2\frac{1}{8} = ,370$

This piece of paper scatters 896 rays of heat, and 549 of light.

198*th Experiment.*

	Sun.	Dark-green paper scattering.
0′	$64\frac{5}{8}$	$65\frac{1}{4}$
5	$69\frac{1}{2}$	$67\frac{3}{4}\ldots 4\frac{7}{8} : 2\frac{1}{2} = ,513$

This paper scatters 1242 rays of heat, and only 308 of light.

199*th Experiment.*

Sun.	Black paper scattering.
$65\frac{1}{2}$	66
$70\frac{1}{8}$	$68 \ldots 4\frac{7}{8} : 2 = ,410$

This paper scatters 993 rays of heat, and 420 of light.

From these experiments it seems to be evident, that in scattering heat, the colour of the object is out of the question; or, at least, that it is no otherwise concerned than as far as it may influence the texture of the surface of bodies. For here we find that pale-green, which is brighter, or scatters more light, than dark-green, yet scatters less heat. Even black, so generally known to scatter but little light, scatters much heat. But, in order to put this surmise to a fairer trial, I made the following experiments with my new machine.

200*th Experiment.*

I covered one of the tablets with white paper, and the other with black. The quantity of sunshine admitted through the two openings, of $1\frac{1}{2}$ inch in diameter each, being equal, I found the heat scattered on both thermometers to be as follows.

	White paper.	Black paper scattering.
0′	$71\frac{3}{4}$	72
5	$75\frac{5}{8}$	$75 \cdots 3\frac{7}{8} : 3 = ,774$

I turned now the tablets, and had,

	Black paper.	White paper scattering.
0′	$73\frac{1}{4}$	$72\frac{3}{4}$
5	$75\frac{3}{8}$	$75\frac{7}{8} \cdots 2\frac{3}{8} : 3\frac{1}{8} = ,760$

These results, agreeing sufficiently well together, shew that if we make white paper our standard, and suppose it to scatter

1000 rays of heat, and 1000 of light, then will black paper scatter 767 rays of heat, and 420 of light.

201*st Experiment.*

	White paper.	Black muslin scattering.
0′	$73\frac{3}{4}$	$73\frac{3}{4}$
5	$77\frac{3}{4}$	$77 \cdots 4 : 3\frac{1}{4} = ,813$

This scatters 813 rays of heat; and, when it is suspended so that the rays which pass through it may not be reflected, it scatters only 64 rays of light.

202*d Experiment.*

As my intention at present was to find a black substance that should scatter more heat than a white one, I thought it would be the readiest way to examine the white and black objects separately, that of all the white ones I might afterwards take that which scattered least, and compare it with the black one which scattered most.

	White paper.	White linen scattering.
0′	$74\frac{7}{8}$	75
5	79	$79\frac{1}{8} \cdots 4\frac{1}{8} : 4\frac{1}{8} = 1{,}000$

These objects scatter heat equally, and very nearly also light; for our table gives for linen 1008.

203*d Experiment.*

	White paper.	White cotton scattering.
0′	$74\frac{1}{2}$	$74\frac{5}{8}$
5	$78\frac{3}{8}$	$78\frac{1}{2} \cdots 3\frac{7}{8} : 3\frac{7}{8} = 1{,}000$

These objects scatter heat equally. White cotton scatters 1054 rays of light.

204*th Experiment.*

	White paper.	White muslin scattering.
0′	$78\frac{3}{8}$	$78\frac{3}{8}$
5	$77\frac{3}{8}$	$76\frac{7}{8} \ldots 4 : 3\frac{1}{2} = ,875$

White muslin scatters 875 rays of heat, and 827 of light.

205*th Experiment.*

	White paper.	White persian scattering.
0′	$74\frac{1}{2}$	$74\frac{5}{8}$
5	$77\frac{7}{8}$	$78\frac{1}{4} \ldots 3\frac{3}{8} : 3\frac{5}{8} = 1,074$

White persian scatters 1074 rays of heat; and, when suspended like the black muslin in the 201st experiment, it scatters 671 rays of light.

206*th Experiment.*

	White paper.	White knit worsted; rough side outwards.
0′	51	$51\frac{3}{4}$
5	$52\frac{5}{8}$	$53\frac{3}{4} \ldots 1\frac{5}{8} : 2 = 1,231$

White worsted scatters 1231 rays of heat, and 620 of light.

207*th Experiment.*

White paper.	White chamois leather; the smooth side exposed.
$74\frac{5}{8}$	$74\frac{5}{8}$
$78\frac{3}{8}$	$79 \ldots 3\frac{3}{4} : 4\frac{1}{8} = 1,167$

White chamois leather scatters 1167 rays of heat, and 1228 of light.

208*th Experiment.*

Black paper.	Black velvet scattering.
$75\frac{3}{4}$	$75\frac{7}{8}$
$79\frac{1}{4}$	$80 \ldots 3\frac{1}{2} : 4\frac{1}{8} = 1,179$

Making now black paper the standard, and supposing it to scatter 1000 rays of heat, and the same of light, then black velvet scatters 1179 rays of heat, and only 17 of light. This last number we obtain, by dividing the tabular number 7, for black velvet, by ,42, which is the proportion of black paper to white.

209th Experiment.

	Black paper.	Black muslin scattering.
0′	$75\frac{1}{8}$	$75\frac{1}{4}$
5	$78\frac{3}{8}$	$79\frac{1}{8} \ldots 3\frac{1}{4} : 3\frac{7}{8} = 1{,}192$

Black muslin scatters 1192 rays of heat, and 43 of light.

210th Experiment.

	Black paper.	Black satin scattering.
0′	$76\frac{1}{4}$	$76\frac{1}{4}$
5	79	$80\frac{1}{8} \ldots 2\frac{1}{4} : 3\frac{7}{8} = 1{,}409$

Black satin scatters 1409 rays of heat, and 243 of light.

211th Experiment.

Having now ascertained, that of all the white and black substances I had tried, white muslin scatters the least, and black satin the most heat, I placed the former on one tablet, while the latter was put on the other.

	White muslin.	Black satin scattering.
0′	$76\frac{1}{8}$	$76\frac{1}{8}$
5	80	$80\frac{1}{4} \ldots 3\frac{1}{8} : 3\frac{7}{8} = 1{,}069$

Here the black object scattered more heat than the white one; but, in order to try again the equality of the tablets and apparatus, I placed the objects under the opposite thermometers, and had as follows.

	Black satin.	White muslin scattering.
0′	78	78
5	$80\frac{5}{8}$	$80\frac{1}{2}\ldots 2\frac{5}{8} : 2\frac{1}{2} = 1{,}050$

So that, notwithstanding some little difference in the apparatus, or other unavoidable circumstances, the black object gave again the greatest scattering of heat; and consequently, as no colour can be more opposite than black and white, colour can have no concern in the laws that relate to the scattering of heat.

212*th Experiment.*

I wished now to try some experiments of the scattering power of metals, and had some plates of iron, brass, and copper, two inches square, set flat, and smooth-filed, by round strokes.

	Iron.	Copper scattering.
0′	74	$73\frac{3}{4}$
5	$78\frac{1}{2}$	$77\frac{7}{8}\ldots 4\frac{1}{2} : 4\frac{1}{8} = ,917$

213*th Experiment.*

	Tin foil.	Gold-leaf paper scattering.
0′	74	74
5	$77\frac{1}{4}$	$79\frac{5}{8}\ldots 3\frac{3}{4} : 5\frac{5}{8} = 1{,}500$

But the tin foil was considerably tarnished.

214*th Experiment.*

Finding the form of the last experiments inconvenient, for want of a standard, I had recourse again to white paper.

	White paper.	Tin foil scattering.
0′	$50\frac{4}{8}$	52
5	$53\frac{1}{8}$	$54\frac{7}{8}\ldots 3\frac{1}{4} : 2\frac{7}{8} = ,885$

This substance scatters 885 rays of heat, and 8483 of light.

215*th Experiment.*

	White paper.	Iron.	
0′	$51\frac{1}{2}$	$53\frac{1}{2}$	
5	$54\frac{1}{8}$	$55\frac{1}{4}$ ... 3 : $2\frac{1}{4}$ = ,750	

Some time having elapsed between the former observation and the present one, this plate of iron was not now so bright as before, and seems to have suffered more than brass or copper from having been laid by: it scatters now only 750 rays of heat, and 10014 of light.

216*th Experiment.*

	White paper.	Brass.
0′	50	$51\frac{1}{4}$
5	$53\frac{1}{8}$	$55\frac{3}{8}$ ... $3\frac{1}{8}$: $4\frac{1}{8}$ = 1,320

It scatters 1320 rays of heat, and no less than 43858 of light.

217*th Experiment.*

White paper.	Copper.
$49\frac{7}{8}$	$51\frac{7}{8}$
53	$55\frac{7}{8}$ ... $3\frac{1}{8}$: 4 = 1,280

It scatters 1280 rays of heat, and 13128 of light.

218*th Experiment.*

White paper.	Gold-leaf paper.
$54\frac{3}{4}$	$55\frac{3}{8}$
$56\frac{1}{2}$	56 ... $1\frac{1}{4}$: $\frac{5}{8}$ = ,857

I changed the tablets to see what difference there might be.

Gold paper.	White paper.
$55\frac{3}{8}$	$55\frac{7}{8}$
$56\frac{1}{8}$	$57\frac{3}{8}$ ... $\frac{3}{4}$: $1\frac{1}{2}$ = ,500

A mean between the two gives ,429. Gold paper, therefore, scatters only 429 rays of heat, and no less than 124371 rays of light.

219th Experiment.

	Black velvet.	Gold paper scattering.
0′	52	$51\frac{7}{8}$
5	$53\frac{1}{8}$	$52\frac{1}{2}\ldots 1\frac{1}{8} : \frac{5}{8} = ,556$

I turned the tablets, in order to ascertain the difference.

	Gold paper.	Black velvet.
0′	51	$51\frac{3}{4}$
5	$51\frac{1}{4}$	$53\ldots\frac{3}{4} : 1\frac{1}{4} = ,600$

From a mean of both it appears, that when black velvet scatters 1000 rays of heat, and only 7 rays of light, gold paper, on the contrary, scatters no more than 578 rays of heat, but 124371 of light.

ART. VII.—*Whether Light and Heat be occasioned by the same, or by different Rays.*

Before we enter into a discussion of this question, it appears to me that we are authorised, by the experiments which have been delivered in this Paper, to make certain conclusions, that will entirely alter the form of our inquiry. Thus, from the 18th experiment it appears, that 21 degrees of solar heat were given in one minute to a thermometer, by rays which had no power of illuminating objects, and which could not be rendered visible, notwithstanding they were brought together in the focus of a burning lens. The same has also been proved of terrestrial heat, in the 9th experiment; where, in one minute, 39 degrees of it were given to a thermometer, by rays totally invisible, even when condensed by a concave mirror. Hence it is established,

by incontrovertible facts, that there are rays of heat, both solar and terrestrial, not endowed with a power of rendering objects visible.

It has also been proved, by the whole tenour of our prismatic experiments, that this invisible heat is continued, from the beginning of the least refrangible rays towards the most refrangible ones, in a series of uninterrupted gradation, from a gentle beginning to a certain maximum; and that it afterwards declines, as uniformly, to a vanishing state. These phenomena have been ascertained by an instrument, which, figuratively speaking, we may call blind, and which, therefore, could give us no information about light; yet, by its faithful report, the thermometer, which is the instrument alluded to, can leave no doubt about the existence of the different degrees of heat in the prismatic spectrum.

This consideration, as has been observed, must alter the form of our proposed inquiry; for the question being thus at least partly decided, since it is ascertained that we have rays of heat which give no light, it can only become a subject of inquiry, whether some of these heat-making rays may not have a power of rendering objects visible, superadded to their now already established power of heating bodies.

This being the case, it is evident that the *onus probandi* ought to lie with those who are willing to establish such an hypothesis; for it does not appear that nature is in the habit of using one and the same mechanism with any two of our senses; witness the vibrations of air that make sound; the effluvia that occasion smells; the particles that produce taste; the resistance or repulsive powers that affect the touch: all these are evidently suited to their respective organs of sense. Are we then

here, on the contrary, to suppose that the same mechanism should be the cause of such different sensations, as the delicate perceptions of vision, and the very grossest of all affections, which are common to the coarsest parts of our bodies, when exposed to heat?

But, let us see what light may now be obtained from the several articles that have been discussed in this Paper. It has been shewn, that the effect of heat and of illumination may be represented by the two united spectra, which we have given.* Now, when these are compared, it appears that those who would have the rays of heat also to do the office of light, must be obliged to maintain the following arbitrary and revolting positions; namely, that a set of rays conveying heat, should all at once, in a certain part of the spectrum, begin to give a small degree of light; that this newly acquired power of illumination should increase, while the power of heating is on the decline; that when the illuminating principle is come to a maximum, it should, in its turn, also decline very rapidly, and vanish at the same time with the power of heating. How can effects that are so opposite be ascribed to the same cause? first of all, heat without light; next to this, decreasing heat, but increasing light; then again, decreasing heat and decreasing light. What modification can we suppose to be superadded to the heat-making power, that will produce such inconsistent results?

We must not omit to mention another difference between light and heat, which may be gathered from the same article of the refrangibility of heat-making rays. It is, that though light and heat are both refrangible, the ratio of the sines of

* See page 439, and Plate XX.

incidence and refraction of the mean rays is not the same in both. Heat is evidently less refrangible than light; whether we take a mean refrangible ray of each, or, which I believe to be the better way of proceeding, whether we take the maximum of heat and light separately. This appears, not only from the view we have taken of the two spectra already mentioned, but more evidently from the 23d experiment, by which we find, that heat cannot be collected by a lens, to the same focus where light is gathered together.

Our fifth article, in which an account has been given of the proportions of heat and light stopped by glasses and other substances, will afford us now an ample field for pointing out a striking difference between these two principles. From the 24th to the 30th experiment, we have the quantities intercepted by colourless substances as follows.

TABLE I.

Bluish-white glass stops	250	rays of heat, and	86	of light.
White flint glass	91		34	
Greenish crown glass	259		203	
Coach glass	214		168	
Iceland crystal	244		150	
Talc	139		90	
Calcinable talc	184		288	

Now, by casting an eye on the above table, it will be seen immediately, that no kind of regularity takes place among the proportions of rays of one sort and of another, which are stopped in their passage. Heat and light seem to be entirely unconnected. The bluish-white and flint glasses, for instance, stop nearly three times as much heat as light; whereas, the

greenish crown glass stops only about one-fourth more of the former than of the latter; but, as coloured glasses take in a much greater range, I will now also give a tabular result of the experiments that have been given relating to them.

TABLE II.

Very dark red glass stops	800 rays of heat, and	$999\frac{9}{10}$ of light.
Dark-red	606	$999\frac{3}{10}$
Orange	604	779
Yellow	333	819
Pale-green	633	535
Dark-green	849	949
Bluish-green	768	769
Pale-blue	812	$684\frac{1}{4}$
Dark-blue	362	801
Indigo	633	$999\frac{7}{10}$
Pale-indigo	532	978
Purple	583	993
Violet	489	955

From this table, I shall also point out a few of the most remarkable results. A yellow glass, for instance, stops only 333 rays of heat, but stops 819 of light: on the contrary, a pale blue stops 812 rays of heat, and but $684\frac{1}{4}$ of light. Again, a dark blue glass stops only 362 rays of heat, but intercepts 801 of light; and a dark red glass stops no more than 606 rays of heat, and yet intercepts nearly all the light; scarcely one ray out of 5000 being able to make its way through it.

Before I proceed to a more critical examination of these results, it will be necessary to add also a table of the same kind, collected from the experiments with liquids.

TABLE III.

Empty tube and 2 glasses stop	542 rays of heat, and	204 of light.
Spring water	558	211
Sea water	682	288
Spirit of wine	612	224
Gin	739	626
Brandy	794	996

To which may be joined, a table containing the stoppages occasioned by scattering substances.

TABLE IV.

Rough crown glass stops	464 rays of heat, and	854 of light.
Rough coach glass	571	879
The 1st doubly rough	667	932
The 2d doubly rough	735	946
The 2 first together	698	969
The 2 next together	800	979
The 4 first together	854	995
Olive colour, burnt in	839	984
Calcined talc	867	996
White paper	850	994
White linen	916	952
White persian	760	916
Black muslin	714	787

We shall now enter more particularly into the subject of these four tables, that we may, if possible, find a criterion by which to judge whether heat and light can be occasioned

by the same rays or not. Now this I think will be obtained, if we can make it appear that stopping one sort of rays does not necessarily bring on a stoppage of the other sort; for, if it can be shewn that heat and light are in this respect independent of each other, it will follow that they must be occasioned by different rays; and I shall make all possible objections to the arguments I mean to draw from these tables, in order to shew that no hypothesis will evade the force of our conclusions.

It has been noticed, that bluish-white and flint glasses stop nearly three times as much heat as light; whereas, crown glass stops only about one-fourth more of the former than of the latter. Now, in answer to this, it may be alleged, "that the "ingredients of which the former glasses are made, dispose "them probably to stop the invisible rays of heat, and that "consequently a great interception of it may take place, with-"out bringing on a necessity of stopping much light; and that, "on the other hand, the different texture of crown glass may "stop one sort of heat as well as the other, so that nearly an "equality in this respect may be produced."

When a hypothesis is made in order to explain any phænomenon of nature, we ought to examine how it will agree with other facts; and, in this case, we are already furnished with experiments, which are decidedly against the supposition that has been brought forward. For, the 148th and 149th experiments shew that the bluish-white and flint glasses transmit all, or nearly all, the invisible rays of solar heat; whereas crown glass, by the 150th experiment, stops a considerable number of them. But, to assist the objecting argument, let it be alleged, as has been proved by the 94th experiment, that our bluish-white glass stops a considerable portion of the heat that goes with the

red rays; then, if the 86 rays of light which this glass stops, are supposed to be all of that sort, the heat which will be stopped in consequence, will, according to the experiment we have mentioned, amount to 86 multiplied by ,375, that is, 32 rays of heat; but, since 250 have been stopped, there will remain 218 to be accounted for.

In this calculation, a manifest concession has been made, which ought to be explained. When I mention 86 red-coloured or red-making rays, I mean so many of them as will make up 86-thousandths of the whole effect of light; for the quantity of heat and light transmitted, or stopped, in all the experiments that have been given, has been reduced to what proportion it bears to unity; and, having afterwards represented the joint effect of every ray of heat and light by 1000, each mean ray of heat must be the thousandth part of that effect; but, a mean ray of light, although it be likewise the thousandth part of the whole effect of light, will not be so of heat, because the whole effect of the latter is partly owing to rays that have been proved to be invisible. On this account, the 86 mean rays of red light, stopped by our bluish-white glass, cannot even amount to a stoppage of 32 rays of heat, which we have allowed.

As I have made the concession on one hand, I must explain an advantage that may be claimed on the other; which is, that mean rays and promiscuous ones have already, in a former Paper, been proved to differ considerably, and that it remains therefore unknown how many red-making rays we may suppose to be stopped, in order to make up 86 mean rays of light. In answer to this, however, I must observe, that the number of promiscuous rays of light and of heat must always be inversely as their power of occasioning those sensations; so that if, for

instance, a red ray is supposed to be twice as heating as a green one, there will only go half the number of them to make up a certain effect of heat; and, on the other hand, if a green ray should have a double power of illuminating, there will be no more than half the number of them necessary to occasion a certain effect of light. But, by my former experiments,* a red ray, though much inferior to a green one, is probably fully equal in illumination to a mean ray of all the colours united together. Now, as red rays have also been proved to be accompanied by the greatest heat, and as our bluish-white glass stops hardly any invisible heat rays, we have certainly gone the full length of fair concessions, by allowing all the light stopped by this glass to be of that sort; and thus it seems to be evident, that the heat which lies under the colours, if I may use this expression, may be stopped, without stopping the colours themselves.

It will not be necessary to lay much stress on this single experiment; our second table affords us sufficient ground on which to rest more forcible arguments. A dark-red glass, for instance, was found to stop 606 rays of heat, and 999,8 of light. This, even at the very first view, seems to amount to a total separation of the two principles; but let us discuss the phænomenon with precision.

As only one ray in 5000 can make its way through this glass, it is evident, that if the rays of light be also those of heat, there can hardly come any heat through it but what must be occasioned by rays that are invisible. It will therefore become a question to be examined, how many of this sort we can admit, if we proceed on a supposition that heat consists of light, as far as that will go. Now this, we find, has already been

* See page 270, 10th experiment.

ascertained, in a great measure, by our 13th, 17th, and 18th experiments. In the 13th, one hundred and twenty degrees of heat were given to a thermometer, in one minute, by the rays which accompany the coloured part of the spectrum. In the 17th experiment, on the contrary, we find only 45 degrees of heat communicated to the same thermometer, in the same time, by the invisible rays of the same spectrum. If we would be more scrupulous, the 18th experiment limits the heat from rays totally invisible even to 21 degrees; but, in order to make every possible allowance, let the proportion be the most favourable one of 120 to 45, which, reduced to mean rays of heat, will give 727 of them visible, and 273 invisible, to make up our thousand.

To return to the experiment: if the total number of rays of heat ascribed to light should accordingly be rated at 727, it is evident, from the stoppage of light of this glass, that 726 rays of heat at least must also be intercepted; and, in consequence of the 153d experiment, which shews that our glass opposes no obstruction to any of the invisible rays, we shall require no more. But, by our present experiment, this glass stops only 606 rays of heat; so that 120 of them will remain unaccounted for. Now, the moment we give up the hypothesis that heat is occasioned by the rays of light, the difficulty becomes fully resolved by our 100th experiment, which shews that full three-tenths of the rays that have the refrangibility of the red are actually transmitted.

In order, however, to make a second attempt to overcome this difficulty, without giving up the hypothesis, it may be supposed, "that perhaps the lens which has been used in the 13th, 17th, and "18th experiments might stop a greater number of invisible

"than visible rays, and that its report therefore ought not to be "depended upon." Now, although it does not appear from the 148th experiment that such a supposition can have much foundation, yet, since those experiments were not made with a view to ascertain the proportion of heat contained in each part of the prismatic spectrum, we cannot lay so much stress upon them as the accuracy which is required in this case renders necessary. Let it therefore, contrary to our 100th experiment, be admitted, in order to explain the phænomenon of the red glass, which stops so much light and so little heat, that all the heat which it intercepts consists entirely of the rays which are visible, and that every one of the invisible rays of heat is transmitted. Then will 999,8 intercepted rays of light be equal to 606 rays of heat; and the remaining 394 will be the number of rays we are now to place to the account of the invisible heat which is transmitted.

Having thus also got rid of this difficulty, we are next to examine how other facts, collected in the same table, will agree with our new concession. A violet-coloured glass, for instance, stops 955 rays of light; these, at the rate of 999,8, or say 1000, to 606, must occasion a deficiency of 579 rays of heat. But, by our table, this glass stops only 489 of them; and there will thus be 90 rays of heat left unaccounted for. To enhance the difficulty, this glass, by our 164th experiment, stops also $\frac{1}{4}$ of the supposed 394 invisible rays, which will amount to an additional sum of 98. And our 111th experiment shews, that actually a great number of these rays, that otherwise cannot be accounted for, come from the store of heat, the rays of which are of the refrangibility of red light.

A dark-blue glass stops 801 rays of light; these, if light and

heat were occasioned by the same rays, would produce a stoppage of 485 rays of heat; but we find that our glass stops no more than 362, so that 123 rays cannot be accounted for by this hypothesis. To this we should add 66 invisible rays, (that is, 394 × ,167,) which, according to our 160th experiment, this glass also intercepts. But the 107th experiment, if we reject the hypothesis, immediately explains the difficulty; for here we plainly see, that only 71 rays of heat of the refrangibility of red light are stopped, whatever may be the stoppage of that light itself.

A yellow glass stops 819 rays of light: these will occasion a stoppage of 496 rays of heat; but this glass intercepts only 333, and therefore 163 rays of heat must also remain unaccounted for. And, turning to the 155th experiment, we find that 79 rays, or $\frac{1}{5}$ of the 394 allowed to be invisible ones, are also to be added to that number.

If in the results of our second table we have had an excess of heat, which the last hypothesis would not account for, we shall, on the contrary, meet with a considerable deficiency, when we come to consider those of the third table.

For instance, our tube filled with well-water, including the glasses at the end, intercepted 211 rays of light. These, at the rate of 606 to the thousand, would produce only a stoppage of 128 rays of heat; but here we find no less than 558 of them intercepted. To evade the pressure of these consequences, it may be said, "that as before every invisible ray was supposed to "have been transmitted through glasses, so they may now be all "intercepted by liquids." And, granting this also to be possible, though by no means probable, for the great extent of these researches has not allowed sufficient time for many experiments

to be made that have been planned for execution; yet, even then, 128 visible and 394 invisible rays to be intercepted, will only make up 522; so that a deficiency of 36 must still remain.

In sea-water, the balance will stand thus: 288 rays of light give 175 rays of heat; these and 394 invisible rays make up 569; but the rays actually intercepted were 682, which argues a deficiency of no less than 113 rays.

But if I have for a moment admitted the entire stoppage of the invisible rays of heat in liquids, the same indulgence cannot be granted for the empty tube, as we know it does neither take place in glasses, nor in air. Therefore we must calculate thus: this compound of glass and air stops 204 rays of light; these can amount only to 124 rays of heat; but it is found to stop 542 of them, so that 418 remain to be accounted for. Now, we certainly can not suppose more than 100 of them to owe their deficiency to the store of invisible heat; so that 318 will still remain unaccounted for.

And thus, from the second table, we have given instances where the assumed hypothesis of visible and invisible heat, in certain proportions, would require a greater stoppage than our experiments will admit; and now, on the contrary, it appears, that interceptions calculated according to the same hypothesis, should be less than the results in the third table give them. From which we conclude, that every other proportion fixed upon, would always be erroneous, either in excess or in defect.

Equal contradictions may be shewn to attend all endeavours to account for the results contained in our fourth table, by admitting any visible heat at all, let the quantity be what it will. To make the proof of this general, let 1000 be the total heat, and assume x for that part of it which we would suppose to be

occasioned by visible rays; then will 1000 — x be the remainder, which must be ascribed to rays that cannot be seen. Now, by our table, we find that crown glass, of which one side has been rubbed on emery, stops 854 rays of light. These alone, if not a particle of invisible heat were stopped, would be equal to ,854 x visible rays of heat, that must be intercepted by the glass. When the other side of this glass has also been rubbed on emery, it will stop 932 rays of light, which will give ,932 x, for the quantity of heat to be intercepted, on the same supposition, that all invisible rays of heat are transmitted. But, by our fourth table, we have the actual stoppage of heat of these glasses; which will therefore give us the two following equations; ,854 $x = 464$, and ,932 $x = 667$. Then, taking the first from the last, and reducing the remaining equation, we obtain $x = \frac{203}{,078}$, for the visible part of the total heat. But $\frac{203}{,078}$, or 2602, being only a part, comes out greater than 1000, which is the whole; and this being absurd, it follows that visible rays of heat cannot be admitted, in any proportion whatsoever. This will equally hold good with any additional stoppage of invisible heat, provided it be equal in both glasses; and, of this equality, the 165th and 167th experiments can leave us no room to doubt.

But it is high time that we should now take into consideration a more direct proof, which may be drawn from our prismatic experiments. The results of them are here brought into a table, as follows.

TABLE V.

Stoppage of prismatic Heat of the Refrangibility of the Red Rays, and of the Invisible Rays.

	Red rays.	Invisible rays.
Bluish-white glass stops	375	71
Flint glass	143	000
Crown glass	294	182
Coach glass	200	143
Iceland crystal	200	——
Calcinable talc	133	250
Dark-red glass	692	000
Orange	500	273
Yellow	417	200
Pale-green	588	375
Dark-green	786	500
Bluish-green	462	800
Pale-blue	700	750
Dark-blue	71	167
Indigo	367	222
Pale-indigo	313	250
Purple	444	273
Violet	400	250
Crown glass, one side rough	389	600
Coach glass, ditto	500	500
Crown glass, both sides rough	471	600
Coach glass, ditto	833	714
Calcined talc	737	889

As a necessary introduction to the decisive experiment I am going to analyse, I must remark, that it has been shewn in a former Paper, that the prism separates invisible heat from the coloured spectrum, by throwing that which is less refrangible than light to one side. But it has also been proved, that heat of the same variety in refrangibility as the different colours, is likewise contained in every part of the coloured spectrum. The question which we are discussing at present, may therefore at once be re-

duced to this single point. Is the heat which has the refrangibility of the red rays occasioned by the light of these rays? For, should that be the case, as there will then be only one set of rays, one fate only can attend them, in being either transmitted or stopped, according to the power of the glass applied to them. We are now to appeal to our prismatic experiment upon the subject, which is to decide the question. First, with regard to light, I must anticipate a series of highly interesting observations I have made, but which, though they certainly claim, cannot find room in this Paper. These have given me the means of acting separately upon either of the extremes, or on the middle of the prismatic spectrum; and by them I am assured that red glass does not stop red rays. Indeed the appearance of objects seen through such coloured glasses, till I can give those observations, will be a sufficient proof to every one that they transmit red light in abundance. Next, with regard to the rays of heat, the case is just the reverse; for, by our preceding table, the red glass stops no less than 692, out of a thousand, of such rays as are of the refrangibility of red light. The incipient stoppage, moreover, or that in two minutes, of which something will be said hereafter, amounts even to 750 rays.

Now, if it should be suspected, "that on account of the great "breadth of prism, some invisible heat may be thrown upon the "spot where the red colour falls," I do not only agree to it, but am certain it cannot be otherwise: but this again, will give additional weight to our present argument; for, by the 153d experiment, as our last table shews, it has already been ascertained, that all such heat will be transmitted through a red glass; so that, were it not for some of this admixture, the stoppage might be still greater.

Here then we have a direct and simple proof, in the case of the red glass, that the rays of light are transmitted, while those of heat are stopped, and that thus they have nothing in common but a certain equal degree of refrangibility, which, by the power of the glass, must occasion them to be thrown together into the place which is pointed out to us by the visibility of the rays of light.

The manifest use of the union of these rays, arising from their equal refrangibility, will be explained at a future opportunity, when I may perhaps throw out several hints that have already occurred to me, where the contents of this Paper may be applied to the useful purposes of life.

There still remains a general argument, that heat and light are occasioned by different rays, which ought not to be omitted. This, on account of the contracted state in which the experiments have been given, cannot appear from my Paper; but, by an inspection of them at full length, it is proved, that the stoppage of solar heat, setting aside little irregularities, to which all observations are liable, has constantly been greater in the first, second, or third minute, than in the fourth or fifth; or, more accurately, nearer the beginning of the five minutes, than about the end of them. Now this does not happen in the transmission of light, which, as far as we know, is instantaneous; at least a failure in the brightness of an object, when first we look at it through a glass, amounting to one, two, or even three minutes, could not possibly have escaped our observation. This seems to suggest to us, that the law by which heat is transmitted, is different from that which directs the passage of light; and, in that case, it must become an irrefragable argument of the difference of the rays which occasion them.

The surmise of a difference in the law of the transmission of heat and of light, is considerably supported by an argument drawn from circumstances of a very different nature. In the scattered transmissions arising from rough surfaces, we find, that when crown glass, for instance, has one of its sides rubbed on emery, it will stop 205 rays of heat more than while that surface remained polished; but the effect of the roughness produced by emery scratches, is far more considerable on the rays of light; the additional stoppage of them amounting to no less than 651.

A confirmation of the same effect we have in coach glass; which, having also one side rubbed on emery, stops only 357 rays of heat more than it did before, while there is an additional stoppage of rays of light, amounting to no less than 717. Now, since the interior construction of these glasses, before and after having been rubbed on emery, remains the same, these remarkable effects can only be ascribed to the roughness of their surfaces. Hence, we may conclude, that as the same cause, when it acts upon the rays of heat and light, produces effects so very different, it can only be accounted for by admitting the rays themselves to be of a different nature, and therefore subject to a different law in being scattered. It has already been shewn, that the rays of heat are, upon an average, less *refrangible* than those of light; and now it appears that they are also, if I may introduce a convenient term, less *scatterable*.

We ought now also to take a short review of the phænomena attending the transmission of terrestrial heat. The results of the experiments which have been given, are drawn into one view in the following table.

TABLE VI.

	Rays of flame.	Fire.	Invisible heat.
Bluish-white glass stops	625	750	700
Flint glass	591	750	533
Crown glass	636	722	783
Coach glass	458	714	625
Iceland crystal	516	756	726
Talc	375	713	615
Very dark red glass	636	618	—
Dark-red	526	573	630
Orange	560	643	524
Yellow	583	685	531
Pale-green	500	688	632
Dark-green	739	745	700
Bluish-green	652	696	556
Pale-blue	609	676	548
Dark-blue	619	704	632
Indigo	679	721	659
Pale-indigo	571	655	700
Purple	520	679	730
Violet	500	615	684
Crown glass, one side rough	741	723	775
Coach glass, ditto	667	758	741
Crown glass, both sides rough	615	791	833
Coach glass, both	680	854	769
The two last but two, together	720	849	—
The two last together	667	897	—
The four last together	870	902	—
Olive-colour, burnt in glass	792	849	636
White paper	792	912	535
White linen	690	910	457
White persian	598	829	—
Black muslin	565	706	—

Let us now examine what information we may draw from the facts which are recorded in this table. The first that must occur is, that a candle which emits light, is also a copious source of invisible heat. If this should seem to require a proof, I give it as follows.

That the candle emits heat along with light, the thermometer has ascertained; and, that a considerable share of this at least must be invisible, follows from comparing together the quantity of light and heat which are stopped by different glasses. The bluish-white one, for instance, stops 86 rays of light, and 625 of heat. Hence, if only visible rays of heat came from the candle, a glass stopping more light, as for instance the dark-red glass, which stops 999,8, ought to stop all heat whatsoever; but the fact is, that it even stops one hundred rays less than the former.

This instance alone shews plainly, that the existence of invisible terrestrial heat in the flame of a candle, is proved; while, on the contrary, heat derived from rays that are visible, remains yet to be established, by those who would maintain that there are any such. But, for the sake of argument, let us endeavour to explain how visible rays of heat may be reconciled with the contents of our 6th table.

"Now although we must allow," it may be said, "that there "is a certain quantity of candle-heat which cannot be seen, we "are however at liberty to assign any ratio that this may bear to "its visible heat-rays. Let us therefore begin with the bluish-"white glass, and make the most favourable supposition we can, "in order to explain its phænomena. Visible or invisible, it stops "625 rays of heat, and also 86 of light. Now, as in the last "column of the table we have likewise the proportional quantity "of invisible heat it intercepts, which is 700 out of a thousand,

"we may surmise that the 914 rays of light, together with the "300 of the invisible rays which are transmitted, make up the 875 "rays of heat which pass through the glass. Hence, by algebra, "we have the number of invisible heat-rays 878, and the number "of the visible ones 122. Then, to try how this will answer, if "1000 rays of light give 122 of heat, 86 will give 10; and, if "out of a thousand invisible rays 700 be stopped, 878 will give "615 to be intercepted. The sum of these will be 625, which is "exactly the number pointed out by our table." Now this being a fair solution of one instance, let us see how it will agree with some others.

Before I proceed, however, I cannot help remarking, that the supporters of visible heat-rays must feel themselves already considerably confined, as our present argument will not allow them more than 122 of such rays out of a thousand.

Now, if the assumption that terrestrial heat is owing to a mixture of visible and invisible rays, in the proportion of 122 of the former to 878 of the latter, be well founded, it ought to explain every other phænomenon collected in our table.

The purple-coloured glass stops 993 rays of light, which, according to our present hypothesis, should stop 121 rays of heat: it also stops 730 invisible rays, which will give 641 rays of intercepted heat; therefore this glass should stop 762 rays of heat, out of every thousand that come from a candle; but, from our table, we find that it stops no more than 520, so that 242 rays cannot be accounted for.

The glass with an olive colour burnt into it, stops 984 rays of light, or 120 of heat, and 637 invisible rays, or 559 of heat. The sum is 679 which that glass should stop; but it stops actually 792; so that, as in the foregoing instance we had a defi-

ciency of 242 rays, we now have an excess of 113; which plainly shews, that no hypothesis of any other proportion between the visible and invisible rays of heat can answer to both cases; and that consequently, not only the present, but every other assumption of this kind, must be given up as erroneous.

I shall not enlarge on these arguments, as I take them to be sufficiently clear to decide the question we have had under consideration. I also forbear going into an examination of what our sixth article, which treats of scattered heat, might afford, in addition to the former arguments. It may just be remarked, that the 211th experiment points out a black object, which scatters more heat than a white one; while the case, as to light, is well known to be the reverse. The 219th experiment also shews, that the scattering of heat of gold paper is considerably inferior to that of black velvet; whereas a contrary difference, of a very great extent, is pointed out between these two substances; for black velvet scatters only 7 rays of light, while the scattering of gold paper amounts to more than 124000. I am well aware that this difference will perhaps admit of a solution on other principles than those which relate merely to the laws of scattering, and confess that many experiments are still wanting to complete this article, which cannot now be given; but, as this Paper is already of an unusual length, I ought rather to apologize for having given so much, than for not giving more.

Table of the transmission of terrestrial scattered Light through various Substances; with a short Account of the Method by which the Results contained in this Table have been obtained.

The transmissions here delivered are called terrestrial and scattered, to distinguish them from others, which are direct and solar; and, in the use I have made of them in the foregoing Paper, it has been supposed that light-making rays, whether direct and solar, or scattered and terrestrial, are transmitted in the same manner; or that the difference, if there be any, may not be considerable enough to affect my arguments materially. In this I have only followed the example of an eminent optical writer, who does not so much as hint at a possibility that there may be a difference. Before I describe my apparatus, I ought to mention that it is intirely founded on the principles of the author now alluded to,* and that no other difficulty occurs in the execution of his plan, than how to guard properly against the scatterings of the lamp: for the light which this will throw on every object, must not be permitted to come to the vanes; since these scatterings cannot remain equal on both vanes, when one of them is moveable. In the following construction, the greatest difficulties have been removed; and a desirable consistency in the results of the experiments, when often repeated, has now been obtained.

A board about fourteen feet long, and six inches broad,† has two slips of deal, an inch square, fastened upon the two sides: these make a groove, for two short pieces to slide in, backwards and forwards. The two sliding pieces‡ carry each a small

* See *Traité d'Optique*, page 16, Fig. 5; *Ouvrage posthume de* M. BOUGUER.

† See Plate XXVI. Fig. 1. ‡ See Fig. 2 and 3.

board or vane; one towards the right, the other towards the left; but so as to meet in the middle, and apparently to make but one when placed side by side. The vanes are covered with a piece of fair white paper, which is to reflect, or rather to scatter light in every direction. To one end of the board is fixed a circular piece of wood, with an opening in it, which is afterwards to be shut up by a small moveable piece,* intended for placing the transmitting objects upon. This moveable piece contains two holes, at the distance of $1\frac{1}{2}$ inch from centre to centre, and $\frac{1}{4}$ inch in diameter each. Against the circular wooden screen, and close over the opening in it, is placed a lantern containing a lamp.† Its construction is such as to admit a current of air to feed the flame from below, by means of a false bottom, and to let it out by a covered roof; and the whole of the light, by the usual contrivance of dark lanterns, is thus kept within, so as to leave the room in perfect darkness. In the front, that is towards the vanes, the lantern has a sliding door of tin-plate, in which there is a parallelogrammic hole, covered with a spout five inches long, of the same shape. Two or three such doors, with different spouts and openings, will be required to be put in, according to the experiments to be made; but the first will do for most of them.

A narrow arm is fastened to the long board, which advances about three feet beyond the screen, and carries a circular piece of pasteboard, that has an adjustable hole in the centre, through which the observer is to look when the experiments are to be made. At the farther end of the long board is a pulley, over which a string, fastened to the back of the slider that carries one of the vanes, is made to pass. This string returns under the

* See Plate XXVI. Fig. 4. † See Fig. 5.

bottom of the long board, towards the other end, where, close to the observer, another pulley is fixed; and, after going also over this pulley, it returns at the top of the board, to the front of the same vane, to which the other end of it is fastened at the back. By pulling the string either way, the observer may bring forward the moveable vane, or draw it back, at pleasure.

At the side of the long board is a scale of tens of inches, numbered from the place of the flame of the lamp, 0, 10, 20, 30, 40, and so on to 160. A pair of compasses being applied from the last ten towards the vane, ascertains its distance from the flame, to as great an accuracy as may be required.

When the transmitting power of a glass is to be tried, it must be placed over one of the holes of the small moveable piece, which then is fastened with a button, upon the opening left for it in the circular wooden screen. Then, looking through the hole of the pasteboard at the two vanes, and bringing that which is seen through the glass near enough to give an image equally bright with that which is seen through the open hole, the observation will be completed. Having measured the odd inches by a pair of compasses, or immediately by a scale, we deduce, as usual, the transmitting power, by taking double the logarithm of the distance of the farthest vane from the lamp, from double the logarithm of the distance of the nearest vane. The remaining logarithm is that of the transmitting power, as compared to the light coming directly to the eye from the other vane.

I have now only to remark, that the use of this instrument requires some practice, especially when coloured glasses are to be examined; it will, however, be found, that the difference of the colour of the two objects, when their light is brought to an equality, may be overcome by a little abstraction, which is

required for the purpose; for, by attending only to brightness, it has often happened to me, that both objects appeared at last of the same colour; which proved to be some mean between the two appearances considered separately.

Some glasses stop so much light, that it will be advisable to take them by the assistance of an intermediate one. Thus, instead of comparing the open vane directly to a red glass, I settle first the ratio of the violet one to that vane; then, taking the ratio of the red to the violet, and compounding these two ratios, the result will be more accurate. The reason for this will be easily comprehended, when the construction of the apparatus is considered. For a red glass, immediately compared to the open vane, would require its object to be brought extremely near the lamp, while the other must remain at a very great distance. This would occasion a considerable difference in the angles, both of incidence and of reflection, between the rays falling on one vane, and on the other. But, by dividing the observation into two operations, we avoid the errors that might be occasioned by the former arrangement.

In the following table, the first column contains the names of the different substances through which light has been transmitted. The second column shews the transmission of light, expressed in decimal fractions; or the proportion which it bears to the whole incident light considered as unity. An arithmetical complement to this fraction, or what it wants to unity, will therefore give us the proportion of light which is stopped by each of the substances contained in the first column; and that quantity multiplied by 1000 is placed in the third column.

TABLE VII.

Substances without colour.	Transmission.	Stoppage.
Bluish-white glass	,914	86
Flint glass	,966	34
Crown glass	,797	203
Coach glass	,832	168
Iceland crystal	,850	150
Talc	,910	90
Easily calcinable talc	,712	288
Glasses of the prismatic colours.		
Very dark red glass	,0001385	999.9
Dark-red glass	,000188	999.8
Orange glass	,221	779
Yellow glass	,681	319
Pale-green glass	,465	535
Dark-green glass	,0511	949
Bluish-green glass	,231	769
Pale-blue glass	,316	684
Dark-blue glass	,199	801
Indigo glass	,000281	999.7
Pale-indigo glass	,0218	978
Purple glass	,00675	993
Violet glass	,0459	955
Liquids.		
Empty tube and two glasses	,796	204
Well-water and ditto	,789	211
Sea-water	,712	288

Liquids.	Transmission.	Stoppage.
Spirit of wine and two glasses	,776	224
Gin	,374	626
Brandy	,00381	996
Scattering Transmissions.		
Crown glass, one side rubbed on emery	,146	854
Coach glass, ditto	,115	885
Crown glass, both sides rubbed on emery	,0685	932
Coach glass, ditto	,0542	946
The two first, together	,03158	969
The two next, together	,0208	979
The four first, together	,00456	995
Olive colour, burnt in glass	,0160	984
Calcined talc	,00345	997
White paper	,00556	994
Linen	,0483	952
White Persian	,0841	916
Black muslin	,263	737

Table of the proportional terrestrial Light scattered by various Substances.

The same apparatus which has been used to gain the results of the preceding table, has also been employed for the following one, with no other difference than that while the vane with the white paper remained on one side, the other vane was successively covered by the objects whose power of scattering light was to be ascertained, and both vanes were viewed directly through the two open holes in the screen; the eye being stationed in the same place as before.

It will be found, that this table contains the scattering of more objects than have been referred to in the preceding paper; but, as I made these experiments in a certain order, I thought it would be acceptable to give the table at full length.

The first column gives the names of the objects; and the second contains the number of rays of light scattered by them, when compared to a standard of white paper, which is supposed to scatter one thousand.

TABLE VIII.

White paper scatters	1000 rays of light.
Message card	1000
White linen	1008
White cotton	1054
White chamois leather, smooth side	1228
White worsted	620
White Persian, suspended	671
White Persian, on whitish-brown paper	719
White Persian, on white Persian	818
White muslin	827
Red paper	158
Deep pink-coloured paper	513
Pale pink-coloured paper	621
Orange paper	619
Yellow paper	824
Pale-green paper	549
Dark-green paper	308
Pale-blue paper	665
Dark-blue paper	149
Indigo paper, with a strong gloss	144

Dark-violet paper scatters	75 rays of light.
Brown paper	101
Black paper, with a strong gloss	420
Black satin	102
Black muslin, suspended	64
Black muslin, upon black muslin	18
Black worsted	16
Black velvet	7
Tin-foil	8483
Iron	10014
Copper	18128
Brass	43858
Gold-leaf paper	124371

I cannot help remarking, that in making these last experiments, I found that black paper could not be distinguished from white; and that, on bringing it a little nearer to the light than it should be to make them perfectly equal, any of my friends who happened to be present, would mistake the black for the white.

EXPLANATION OF THE PLATES.

Plate XX, represents the spectrum of heat A, S, Q, A; and of light G, R, Q, G. If a prism be placed in a window, so as to throw the colours of light upon a table, and Plate XX be laid under the colours, so that they may respectively fall upon the places where their names are inserted, then may these colours be made to fit into their proper spaces, by lowering or raising the prism, at pleasure. When the colours occupy their proper situations, the line A Q will express the space over

which the prism, by their different refrangibility, scatters the rays of heat; and the ordinates to A Q will nearly express the proportional elevations, which a set of equi-changeable thermometers would experience, when placed in the different situations of these ordinates.

Plate XXI. Fig. 1. A, B, is the box which holds the two thermometers, No. 1 and No. 5. C is the board which contains the transmitting holes, the slip of wood for supporting the glasses, and the perpendicular pin for adjusting the angle. D, E, are the boards joined together by hinges. F is a slip of mahogany screwed to E. G is the spring to confine the slip F; which will keep the board D up to any angle less than 90 degrees.

Fig. 2, is the cover for shutting the transmitting holes.

Plate XXII. Fig. 1, is the screen, which may be elevated, by the usual contrivance of springs at the back, to any required height, so as to permit the rays of the sun to pass through the opening in the middle, and to fall upon the transmitting holes of the box A, B, in Plate XXI.

Fig. 2, is a second upper part of the box A, B, in Plate XXI. The first upper part being screwed off, this is to be put on instead of it, when experiments with liquids are to be made. It contains, as before, the two transmitting holes, the slip of wood, and the pin; and it has moreover a small bracket fastened under one of the holes, on which the tube containing the liquid to be tried may be laid.

Fig. 3, is a third upper part to the box A, B, of Plate XXI. It contains two small holes, for transmitting prismatic rays to the two thermometers A and B, which must now be put into the box, instead of No. 1 and No. 5. The parallel lines *a*, *b*, inclos-

ing the holes, will direct any coloured rays to the thermometers; and, by drawing the red rays down to the lower parallels *c* or *d*, invisible rays may be brought to enter the transmitting holes.

Fig. 4, is a fourth upper part to the box A, B, Plate XXI. It contains two large holes, for admitting the rays of the sun to fall upon the objects on Fig. 5.

Fig. 5, represents two tablets, *a*, *b*, united; they may be covered with any objects that are to be examined; for instance, *a* with white paper, and *b* with black velvet. These tablets, by a proper contrivance, are brought under the holes of figure 4, where a button fastens them at the required distance.

Plate XXIII. Fig. 1. A, B, is the box which holds the thermometers. C, D, are the screens, with the transmitting holes in them, opposite the flame of E, the candle. F, is a small weight, stretching a string across the glass, or other object, placed upright against the transmitting hole of the screen D. It may be carried round the screen C, if required, and hold a glass against the hole in it.

Fig. 2, is the double cover: in putting it on, it must be passed over the candle downwards, against the two transmitting holes.

Plate XXIV, represents a large screen, with the shelf A, B, carrying four thermometers, No. 1 and No. 5 opposite the transmitting holes, and the other two as represented. When the fire is properly prepared, lift the screen, by taking hold a little above A and B, and set it close to the fire, so that C, D, may touch the bottom of the grate; then take hold of the ring E, and pull the string far enough out to hang that ring on the hook F: this will open the transmission holes, when the experiment is to begin.

Plate XXV. Fig. 1, is the box containing the thermometers.

The bricks are piled up, as represented in Fig. 3. The stove, Fig. 2, being prepared, bring the stand, and brick-work, Fig. 3, close to it; and set also the two spare bricks, which lie on the stand, upon the front of the stove, that no heat may pass from the top of it to the brick inclosure; then put the box, Fig. 1, into the brick-work, close up to the stove, and begin the experiment. The ash-hole should also be covered with a brick.

Plate XXVI, Fig. 1, represents the Photometer. The hole at A, is for the observer to look through, that he may have a fixed station. The vanes F and G are moveable. By pulling the string at H, G will be brought nearer the lamp placed at K; and, by drawing the same string at I, it will be removed towards the vane F; which latter may be fixed at any distance most convenient for the experiment.

Fig. 2 and 3, shew the mechanism of the adjustable vane 2, and moveable one 3. There are, however, hooks on fig. 2, which will occasionally receive the strings from the hooks on fig. 3, when a motion of the left vane, instead of the right, is required.

Fig. 4, contains two limiting holes B, C; over one of which, C, a glass may be laid. This piece is to be buttoned on the rabbet of the screen, at D E, fig. 1. When liquids are to be tried, the second piece of fig. 4, which contains a bracket for supporting the transmitting tube, is to be fastened on D E, fig. 1, instead of the former plate.

Fig. 5, gives a view of the lamp and its sliding door, with the spout L, which, when the lamp is placed at K, fig. 1, conveys the light to the vanes F and G, without permitting it to be scattered on the long board.

XX. *An Account of the Trigonometrical Survey, carried on in the Years* 1797, 1798, *and* 1799, *by Order of* Marquis Cornwallis, *Master-General of the Ordnance. By Captain* William Mudge, *of the Royal Artillery, F. R. S. Communicated by his Grace the* Duke of Richmond, *F. R. S.*

Read July 3, 1800.

INTRODUCTION.

HAVING interspersed in the following Paper, with as much attention to brevity as the subject admits, every intelligence relating to the Trigonometrical Survey, I think it unnecessary to swell the bulk of the communication, by giving a long prefatory account of its progress since the year 1796.

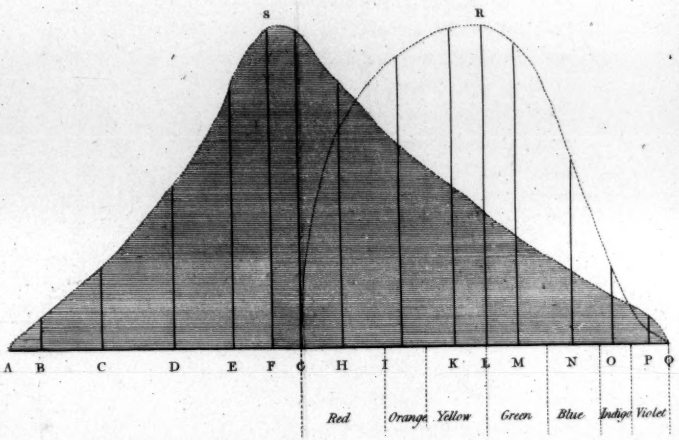
The contents of the work now meeting the public eye, are important and numerous: I have divided it into sections. The first contains the calculations of the sides of the principal and secondary triangles extended over the country in 1797, 1798, and 1799; together with an account of the measurement of a new base line on Sedgemoor, and a short historical narrative of each year's operation. The second section contains the computed latitudes and longitudes of those places, on the western coast, intersected in 1795 and 1796, and also such others, since determined, as lie conveniently situated to the newly-observed meridians. This section also contains the directions of those meridians; one on Black Down, in Dorsetshire; another on Butterton Hill, in Devonshire; and another on St. Agnes Beacon,

in Cornwall. Among the contents are likewise to be numbered the bearings, distances, &c. of the stations and intersected objects, from the parallels and meridians.

The third and last section contains the triangles which have been carried over Essex, the western part of Kent, and portions of the counties joining the former, Suffolk and Hertfordshire. It is with satisfaction I am enabled to state, that Mr. GARDNER, the chief Draftsman, with his assistants, has almost completed the Survey of this extensive tract, which, no doubt, like the map of Kent, will be given to the public: the materials for these different surveys are ample, and will be found in this section, which concludes with the altitudes of the stations and mean refractions.

Before I had advanced far in my work, I entertained ideas of condensing all the *data* in my possession, and distributing them in it; but, when I found my paper would, in that case, be too large for the Philosophical Transactions, I desisted, contenting myself with presenting little more than a moiety: it is, even now, of inconvenient magnitude, but I could not, with propriety, still farther abridge it, for I have, in several instances, rejected important matter. I shall, therefore, take an early opportunity of compiling a fourth account, in which will be given the latitudes and longitudes of those places, in Essex, Kent, &c. found in the last section.

It is right I should observe that, knowing from experience, how liable surveyors are to mistake the names of places, and also, how utterly impracticable it is to detect errors, till the interiors of the great triangles have been *filled up*, I have been cautious to give only the distances of such objects as could not be easily mistaken. I do not mean to insinuate that, among


S
R
A
B
C
D
E
F
G
H
I
K
L
M
N
O
P
Q
Red
Orange
Yellow
Green
Blue
Indigo
Violet

Basire sc.

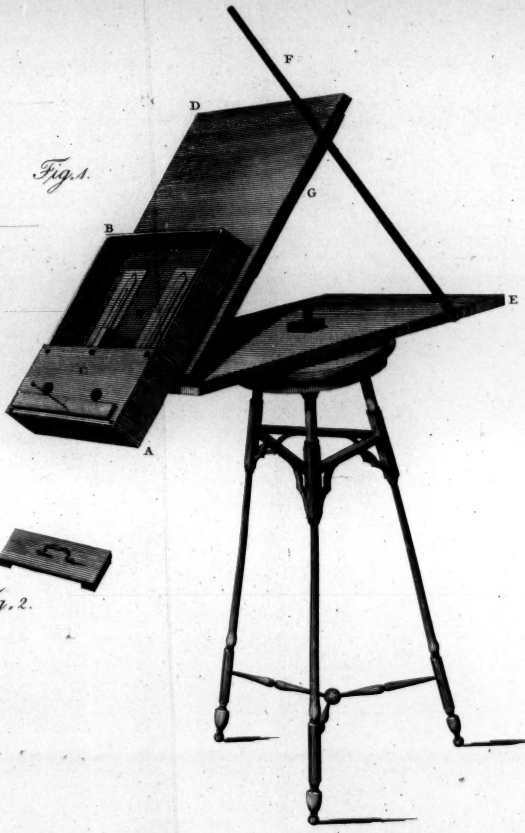


Fig. 1.

Fig. 2.

Basire fc.

Fig. 1.

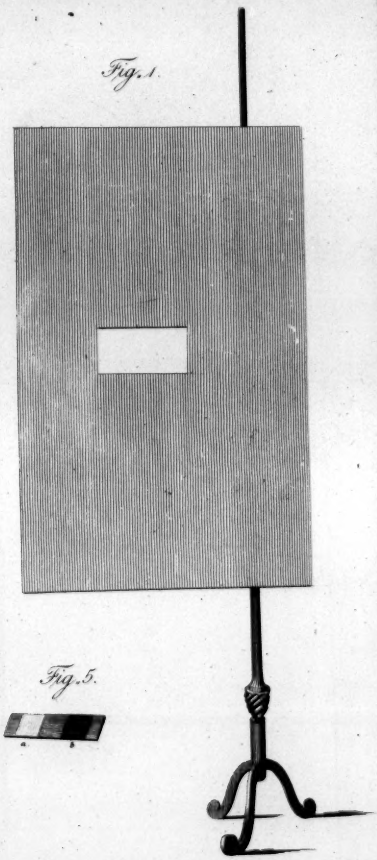


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Basire. fc.

Fig. 1.

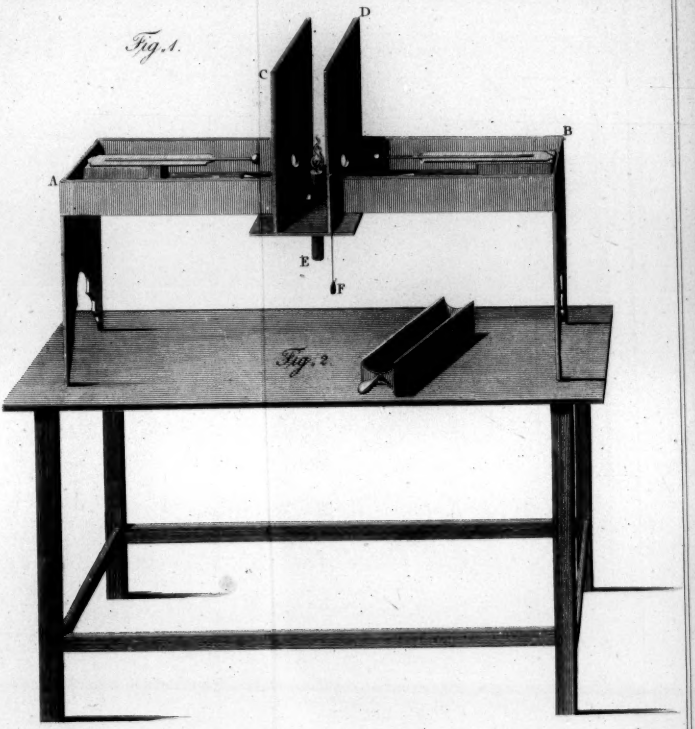
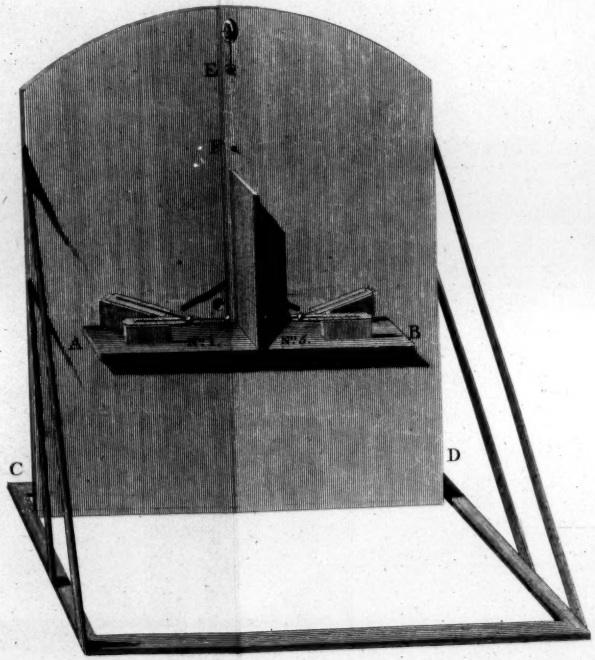


Fig. 2.

Bassire sc.



Basire fc.

Fig. 2.

Fig. 3.

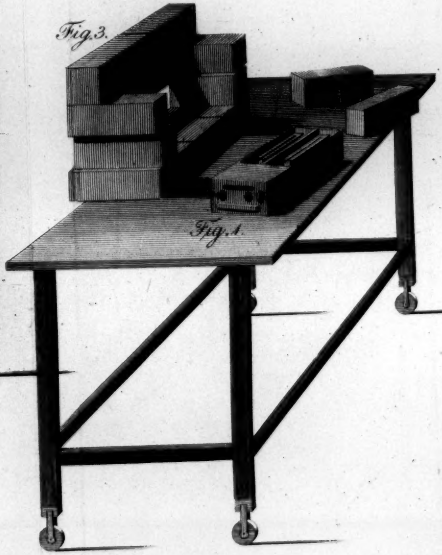


Fig. 1.

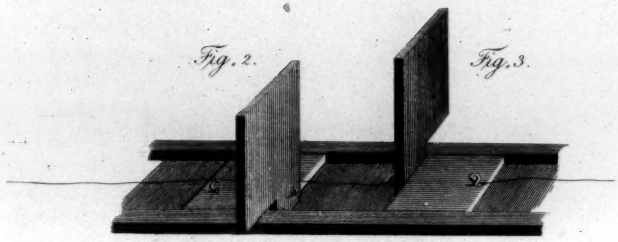


Fig. 2.
Fig. 3.

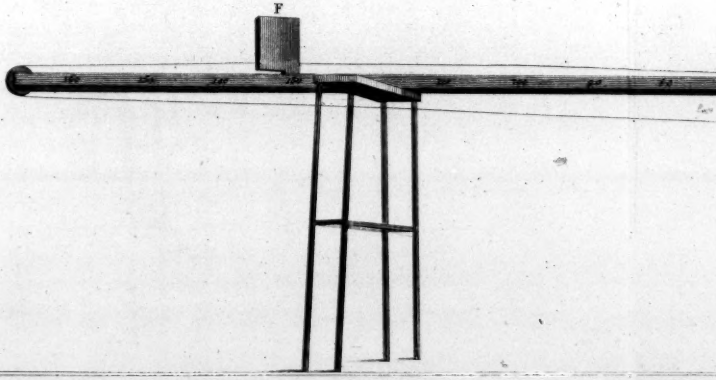

F

Fig. 5.

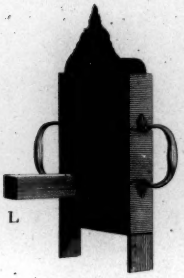
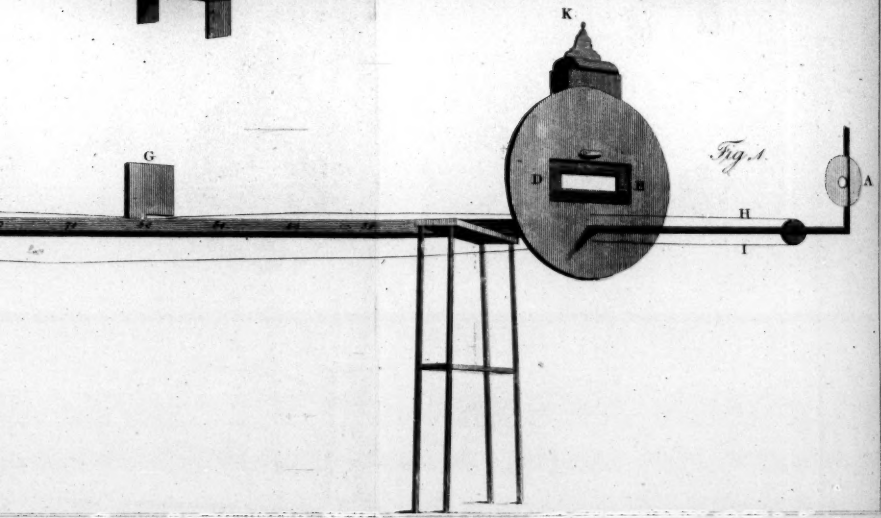


Fig. 4.

Fig. 1.



Basire sc.

the great number now published, instances may not be found of misnomers, or even wrong bearings; but I rely with great confidence on their general accuracy, and particularly on those constituting the surveys of Essex and the northern shore of the Thames, as the whole of them have been *verified* by Mr. GARDNER. Indeed this is to be understood as holding good throughout the last section, in which are 375 triangles. In our former accounts of this survey, we were particularly guarded in not intermixing their contents with distances determined from numerous doubtful intersections; and experience has hitherto not detected above three or four errors arising from wrong bearings or misnomers. Previously, indeed, to the compilation of them, a great part of the objects in Sussex, Hampshire, and the Isle of Wight, were verified by Mr. GARDNER, in process of an extensive survey, carried on by the order, and performed for the service, of the Board of Ordnance. This gentleman will also have it in his power to detect any errors, if such exist, in the names of places to the westward; as the Master General has been pleased to issue his directions for the survey of Devonshire, and as much of Somersetshire and Cornwall as will *square* the work.

I have mentioned, in the body of the account, that the President and Council of the Royal Society, were pleased to accede to the request made by the Honorable Board of Ordnance, to entrust to my care, the circular instrument used by the late Major General ROY, in his well known operation. It has already been found highly useful, and will shortly prove to be still more so, as one theodolite will be employed in carrying the above orders of Marquis CORNWALLIS into effect, while the other is used in carrying a meridional line through the country; an undertaking begun, and partly executed.

Before I close this Introduction, I am to announce, that Mr. Isaac Dalby, no longer able to endure the fatigues incident to the service, has retired from it; and it would be a matter of injustice, if I were not to acknowledge the extent of his services, his unremitted labour, and attention. But, whilst I lament the loss of a man so perfectly calculated to assist me in this arduous undertaking, I derive every consolation from a knowledge, founded on experience, of the talents and abilities of Mr. Simon Woolcot, his successor.

SECTION FIRST.

1. *Particulars relating to the Operations of the Year* 1797.

The principal object proposed to be accomplished this year, was the determination of the directions of meridians at proper stations, in order to afford the necessary *data* for computing the latitudes and longitudes of places intersected in the surveys of 1795 and 1796.

From errors which are the result of computations made on the supposition of the earth's surface being a plane, it is expedient that new directions of meridians should be observed, when the operations are extended, in eastern or western directions, over spaces of sixty miles from fixed meridians. The distance from Dover to the Land's End being upwards of 300 miles, it becomes necessary, on this principle, that four directions of meridians should be observed; which, with that of Greenwich, amounts to five, dividing this space into six nearly equal parts.

Whatever be the stations farther to the westward, which offer

themselves as fit places for these observations, Dunnose in the Isle of Wight presents itself as highly eligible, not only because it is removed the necessary distance from the meridian of Greenwich, but also because it commands a most extensive view of the western coast: therefore, as the direction of the meridian was observed on this station in 1793, (see Philosophical Transactions for 1795, p. 517.) it became necessary to fix on three places only.

In the selection of these stations, it was our wish to have found such as should lie nearly in the same parallel, each intermediate one being visible from those east and west of it; by which means, the differences of latitude between their respective parallels would be accurately determined.

When the party was at Dunnose, in the year 1793, a hill at a very considerable distance, in a direction very nearly west, was seen just rising out of the horizon. It then occurred to us that this spot would, at some future period, be a very proper one for a station whereon a new direction of the meridian might be observed. Experience, in the Survey of 1795, led us to believe this hill was actually Black Down in Dorsetshire; therefore it was determined that our operations should commence at that station, and the event verified the truth of our suppositions.

The party took the field early in April, as observations on the Pole Star, for the purpose in question, are made with superior advantage at this season of the year, because the star comes to its greatest elongations from the meridian at those times, when the sun produces little tremor in the air, by which means, the staff to which the Pole Star is referred, in good weather, is easily perceived.

As the high land in the vicinity of Teignmouth, in Devonshire,

cuts off all view of the southern extremity of Dartmoor from Black Down, the necessary alternative was, the firing of lights on some remote station, communicating with Butterton. Rippin Tor was quickly discovered to be the most proper spot; and that eminence would, in every point of view, be a most eligible one for a new direction of the meridian, if the hills in the middle of the moor were not considerably higher. It was, therefore, chosen only with a view of being subservient to the purpose of finding the latitude of Butterton.

In making observations on the Pole Star, the same precautions were taken to ensure accuracy, as were observed at Dunnose and Beachy Head in the year 1793; (see Phil. Trans. for 1795, p. 460.) I shall, therefore, not enumerate them, but content myself with observing, that no pains were spared in this performance.

From Black Down, the party removed to Butterton; at which place but few observations were made, the weather being either tempestuous or hazy, during the greatest part of the time we were at that station: they were, however, made under favourable circumstances, in other respects, and are therefore likely to afford accurate results.

As in the case of Rippin Tor, with respect to Black Down, so Hensbarrow, in Cornwall, was selected as the spot for connecting St. Agnes Beacon with the station on Butterton; for these latter are not visible from each other, the high land about St. Austle, on the northern part of which is situated Hens or Hengist barrow, being higher and intermediate. The staff to which the lights and star were referred, was placed on a hill called Hemmerdon Ball, a secondary station in the series of 1795.

On the 1st of May, the party proceeded to St. Agnes Beacon; at

which place the observations were completed on the 8th. The staff for connecting the observations made on the Pole Star with those made on the lights fired at Hensbarrow, was placed near Peranzabulo; which spot is laid down in the plan, Pl. XXVII.

After these directions of meridians were determined, we proceeded with the survey, and from St. Agnes Beacon repaired to Trevose Head, a promontory on the northern coast of Cornwall. The ascent from the sea to the station on this headland being very gradual and unobstructed, we took the opportunity of finding its altitude by means of the transit instrument. The levelling was begun on the 30th of May, and finished the following day; from which operation, it was found that the height of the station above low water-mark was 274,2 feet; which is, probably, within six inches of the truth. This base of altitude, will afford the means of computing the heights of the stations in the north of Devon, and also of verifying those in the western part of Cornwall. (See Phil. Trans. for 1797, p. 471.)

In giving an account of this and similar articles, it is my intention merely to set forth the order in which the different parts of the survey have been performed. It would be prolix, and perhaps, unnecessary, to assign the reasons for the choice of each station. In the present instance, however, it may not be improper to observe, that a station called Black Down, near Lydford, was selected for the purpose of carrying distances into the north of Devon, by means of the side formed by that station and Carraton Hill. The difficulty of running up the series of triangles from the west, (and it might have been also added, towards the north,) is mentioned in the account of 1797. A tract of country exists in Cornwall, possessing the same characteristic features with Dartmoor, and has thrown in our

way equal embarrassments. The station called Carraton Hill, is situated on its southern extremity, from which no part of the north of Cornwall can be seen: it, therefore, became expedient to erect a staff on the top of the rugged hill Brown Willy, (a spot not accessible to the instrument,) and afterwards to content ourselves with *surveying round it*. This resolution became the more necessary, as by means of it, the triangles in the west of Devon will be hereafter connected with those in the north of Cornwall, in a shorter and more direct way than from the sides in the more southern country. In order, therefore, to observe the staff erected on this station, the instrument was taken a second time to Bodmin Down. The station named Cadon Barrow, near Camelford, and those on St. Stephen's Down, near Launceston, were also visited; at which time it was judged expedient to discontinue the operations in Devonshire.

In proceeding along the southern coast, in the years 1795 and 1796, with a single chain of triangles, we acted in conformity with our instructions. It was, in many points of view, the most eligible mode of proceeding; and particularly in that which regarded an early determination of the latitudes and longitudes of the great head-lands in the channel, and also of the Scilly Isles.

When the operations above spoken of were completed, and those instructions carried into full execution, (ample materials being provided for ascertaining the situations of every remarkable point on the English side of the channel,) the want of a spot in the southern part of Cornwall, for the measurement of a base, was felt and regretted; we were, therefore, unwilling to introduce errors, if any should exist, from the sides in Cornwall, into the north of Devon: our operations were consequently discontinued.

From Devonshire we proceeded to the eastward, for the purpose of carrying on a second series of triangles. These were necessarily intended to originate from the side which connects the station on Beacon Hill, near Amesbury, with that on Wingreen Hill, near Shaftesbury.

In the month of July, the observations were completed at the station on the Mendip Hills, after which the instrument was taken to Bradley Knoll; Dundry Beacon, near Bristol; Lansdown and Farley Down; the station on Lansdown being chosen rather for a secondary than a principal place of observation.

From Bradley Knoll, to which place the instrument was carried from Farley Down, we proceeded to Westbury Down, and from thence to Beacon Hill, near Amesbury; because it was necessary that a new point on the range near Marlborough, commonly named St. Ann's Hills, should be observed. The station formerly chosen at the eastern extremity of this range, and observed in 1794, (see Phil. Trans. 1795, p. 471.) was this year found to be useless, as the high land, on the same range, prevented it from being seen at Lansdown: two others were, therefore, selected to the westward of the former, and observed from Beacon Hill; one for the purpose of connecting with Lansdown, and a station near Symmond's Hall, in Gloucestershire; and the other with Inkpin Beacon. The particular circumstances of this range, both as to situation and height, have thrown great impediments in the way of the survey, and are the means of cutting off, in a considerable degree, the connection between the southern triangles and those which have been since carried on in the midland of the kingdom. From Amesbury the party proceeded to Inkpin Beacon, near Hungerford, where the operations terminated.

The stations chosen and observed this year, but not visited with the instrument, were Monymoor, near Penhow; the mountain Twymbawlin, near Newport; and Scilly Point, in Glamorganshire. These stations in South Wales will connect with three in Somersetshire, also selected this season; one on Bleak Down, which is situated on the western extremity of the Mendip range; a second on Brent Beacon; and a third on the Quantock Hills.

Subsequent to the operations on Salisbury Plain, enquiries had been often made after a spot on which a third base might be measured. Experience had almost convinced us that, if Sedgemoor were excepted, the southern part of England did not contain one of sufficient extent for a base of three miles. Aware, therefore, of the imperfect state in which our work must rest, without a fresh base, Mr. DALBY and myself passed over into South Wales, and examined the extensive level between the new Passage House and Cardigan. After, however, a very diligent search, we could not find any spot, four miles in length, sufficiently unobstructed. The advantages which the situation itself holds out, are so great, that we should not have scrupled to dispense with a desideratum, heretofore required, of the base being one continued line. So much, however, is this flat cut up with *rhynes* and ditches, that we were not able to find any point from which two right lines might be measured, and so inclined to each other as to afford, by means of an including angle, a third side of five miles in length: necessity, therefore, compelled us to think of measuring a base on Sedgemoor, which we immediately examined. That which relates to this situation, will be found in an ensuing article: it is now only necessary to observe, that we concluded the operations of 1797, after the practicability of measuring a base upon it had been decided in the affirmative.

ART. II. *Angles taken in the Year 1797.*

At Black Down.

Between	°	′	″	Mean.
Dunnose and Abbotsbury staff	164	26	33,75	35,25
			37	
Rippin Tor and Abbotsbury staff	3	8	51,75	52,5
			52,75	
Pilsden and Abbotsbury staff	45	16	15	14, but 13 preferred.
			13	
Pole star and Abbotsbury staff, April 17, morning	104	19	26,75	
18, morning	104	19	19,25	
19, morning	104	19	33	
19, afternoon	98	42	47	
20, morning	104	19	25,25	
20, afternoon	98	42	35,5	

At Butterton.

Hemmerdon Ball and Rippin Tor	121	17	7,25	7,75
			8,5	
Hemmerdon Ball and Hensbarrow	1	52	2,75	4,5
			6,25	
Pole star and staff on Hemmerdon Ball, May 6, afternoon	91	29	13,75	
7, morning	97	4	14	
7, afternoon	91	29	18	

On St. Agnes Beacon.

Hensbarrow and Trevose Head	47	10	0,75	
Hensbarrow and Peranzabulo staff	31	50	55,5	56, but 55,5 pref.
			56,25	
Pole star and Peranzabulo staff, May 20, afternoon	44	0	45,75	
21, afternoon	44	0	44,75	
22, morning	38	26	1,5	
22, afternoon	44	0	33,25	
23, morning	38	26	9	

At Trevose Head.

St. Agnes Beacon and Hensbarrow	65	43	43,75	47
			47	
			50	

Between	°	′	″		Mean
Hensbarrow and Bodmin Down	34	17	45	}	45,5
			46	}	
Bodmin Down and Cadon Barrow	42	33	43	}	rejected.
			46,5	}	
			51,75	}	52
			52,75	}	

At Hensbarrow.

St. Agnes Beacon and Trevose Head	67	6	13,25	}	13,25
			13,25	}	
Bodmin Down and Trevose Head	77	20	17,75	}	18,5
			19,25	}	

At Bodmin Down.

Hensbarrow and Trevose Head	68	21	57,25	}	58,25
			59,5	}	
Trevose Head and Cadon Barrow	71	55	26,75	}	27
			27	}	
Carraton Hill and staff on Brown Willy	52	3	59,5		
		4	1,25	}	1,75
			4,5		
Carraton Hill and picket on Brown Willy	51	36	11	}	11
			11	}	
Cadon Barrow and staff on Brown Willy	30	58	13	}	13
			13	}	
Cadon Barrow and picket on Brown Willy	31	26	0,25		
			1,25	}	1,75
			3,25		

On Cadon Barrow.

Trevose Head and direction post on Bodmin Down	68	7	53,75		
			54	}	54,25
			54,25		
			54,75		
Direction post on Bodmin Down and staff on Brown Willy	41	12	37,5		
			39	}	39,25
			41		
Direction post on Bodmin Down and picket on Brown Willy	40	40	34	}	35,25
			36,75	}	
Tresparrot Down and staff on Brown Willy	100	20	52,25		
			55	}	54,75
			57		
Tresparrot Down and picket on Brown Willy	100	53	1	}	1
			1	}	

At St. Stephen's Down.

Staff on Brown Willy and Warbstow	41	18	24,25	}	25
			25,5	}	

Between	°	′	″	Mean.
Warbstow Beacon and Brendon Moor	39	41	18,5	18,75
			18,75	
			19	
Brendon Moor and Broadbury Down	90	0	40,75	41
			41	
Broadbury Down and Black Down	45	34	36 D	
			41,75	42,25
			43	
Black Down and Carraton Hill	91	18	12,25	12,75
			13,5	
Carraton Hill and Kit Hill	37	1	56	
Black Down and Kit Hill	54	16	13	

At Maker.

Carraton Hill and Black Down	53	4	28	29,25
			30,5	

At Carraton Hill.

Black Down and Maker Heights	74	5	22,5	22,5
			22,75	
Trevose Head and Bodmin Down	77	20	17,75	18,5
			19,25	

At Black Down.

Maker Heights and Carraton Hill	52	50	7,75	9,75
			11,75	
Carraton Hill and St. Stephen's Down	39	44	37,25	39
			40,75	
St. Stephen's Down and Broadbury Down	66	49	57,5	58
			58,25	
Carraton Hill and Kit Hill	13	12	58	

On the Mendip Hills.

Dundon Beacon and Bleak Down	85	15	59,25	1,25
			59,75	
		16	1,5	
			4,5	
Bleak Down and Brent Knoll	29	11	35,75	39,25
			38	
			41,25	
			41,75	
Bleak Down and Dundry Beacon	33	39	30,5	30,5
			30,5	

Between	°	′	″	Mean.
Dundry Beacon and Lansdown	41	3	58,5	58,5
			58,75	
Lansdown and Farley Down	19	32	16,5	16,75
			17	
Farley Down and Westbury Down	38	55	17	17,5
			18,25	
Westbury Down and Bradley Knoll	37	47	57	58,5
			57,75	
			58,75	
			59	
	48		0,25	
Farley Down and Dundry Beacon	60	36	15	15,5
			15,75	
Farley Down and Bradley Knoll	76	43	14	19,75
			18,5	
			21	

At Dundry Beacon.

Tickenham Down and Grey Hill	37	44	2,25	3,75
		3	3	
			6,25	
Tickenham Down and Kingsweston	60	3	27,25	28,75
			30	
Kingsweston and Grey Hill	22	19	23,5	25,75
			27,75	
Bleak Down and Grey Hill	120	0	23	25
			24	
			28	
Lansdown and station on the Mendip Hills	83	34	16,25	18
			19,75	
Farley Down and Mendip Hills	69	52	21	22
			23	
Mendip and Bleak Down	54	34	24	25,5
			25,75	

At Lansdown.

Kingsweston and Dundry	36	38	29	

On Farley Down.

St. Ann's Hill and Westbury Down	51	44	10,75	11,75
			11	
			11,25	
			13,75	
Westbury Down and Bradley Knoll	37	5	30,75	32,5
			31	
			34	
			34,25	

Between	°	′	″	Mean.
Westbury Down and Mendip Hills	77	21	51,75	53,75
			55,75	
Bradley Knoll and Mendip Hills	40	16	23	23,5
			23,75	
Mendip Hills and Dundry Beacon	49	31	15,25	rejected.
			21,5	
			23	23,5
			23,75	

On Bradley Knoll.

Mendip Hills and Westbury Down	191	23	56,5	59
			57,75	
		24	0	
			1,75	
Westbury Down and Beacon Hill	42	43	29,25	29,75
			30,5	
St. Ann's Hill and Westbury Down	7	28	44	45
			45,25	
			46,5	
Westbury Down and Milk Hill	10	12	49,5	51,5
			53,25	
Beacon Hill and Wingreen	57	50	38,25	
Beacon Hill and Bull Barrow	98	34	31	32,5
			33,5	
			34	
Wingreen and Bull Barrow	40	43	51,25	52
			52,75	
Bull Barrow and Ash Beacon	45	43	3,25	3,5
			3,75	
Ash Beacon and Mendip Hills	71	34	54,75	55
			55,25	
Mendip Hills and Farley Down	63	0	21,5	

At Bull Barrow.

Ash Beacon and Mintern	51	26	41	42
			41,75	
			43	
Bradley Knoll and Wingreen	42	55	32,75	

At Pilsden Hill.

Mintern and Ash Beacon	35	2	59	1
		3	3,25	

At Mintern.

Between			Mean.
Pilsden and Ash Beacon	95 35 21,25	22,5	22
Ash Beacon and Bull Barrow	94 14 22	24	23

On Westbury Down.

Beacon Hill and Bradley Knoll	114 12 18,25	18,5	18,5
Bradley Knoll and Mendip Hills	40 48 1	1,75	1,75
Mendip Hills and Farley Down	63 42 50,5	52	51,25
Farley Down and St. Ann's Hill	88 50 1	3	2,75
St. Ann's Hill and Beacon Hill	52 26 42,25	43,25	42,75
Beacon Hill and Milk Hill	48 7 31	36	33,5

Beacon Hill (Amesbury.)

Bradley Knoll and Westbury Down	23 4 15		
Inkpin Down and Milk Hill	66 14 58		
Inkpin Down and St. Ann's Hill	70 51 57,5	57,75	57,75
Westbury Down and Milk Hill	51 11 9		
Westbury Down and St. Ann's Hill	46 34 6	9,25	7,75

On Inkpin Down.

White Horse Hill and Highclere	133 27 57,25	57,5	57,5
Highclere and Beacon Hill	106 16 52,25	54,25	53,25
Beacon Hill and Hewish	51 53 31,25	33,5 35	33,25

ART. III. *Particulars relating to the Operations of the Year* 1798.

The object first attained this year, consisted in a trigonometrical survey of the counties adjacent to the northern and southern shores of the Thames.

In the last communication it will be seen, that the survey of Kent had been carried on from the sea-coast, till it reached the range which runs eastward from Wrotham through Hollingbourn, and there terminated. The country to the northward could not be surveyed, because the view from General Roy's station at Wrotham is almost entirely cut off, in that direction. In order, therefore, to obtain a base for the purpose, when the party arrived at Wrotham, a new station was chosen, to the eastward of the former one, and the distance between them accurately measured; by which means, together with the included angle at the old station, and the distance of it from Severndroog Tower, on Shooter's Hill, a new distance was found, which became a base for the survey proposed.

The chief draftsmen and surveyors belonging to the Drawing-room in the Tower, attended our operations in this county, and also those afterwards carried on in Essex. It was, indeed, for their immediate service, that we renewed the survey in this quarter, as the Master-General had given directions to prepare ample materials for completing the map which meets the public eye with this article.

The stations in Kent, besides that of Wrotham, were Gravesend, Gad's Hill, and the Isle of Sheppey; those in Essex were Hadleigh, South End, and Prittlewell. Observations made from these places afforded *data* for the proposed survey: after they were completed, the small circular instrument supplied the

place of the great one, and was used, with good effect, in carrying on the subsequent operations in this quarter.

In our Paper published in the Philosophical Transactions for 1795, an observation is made, of the necessity then existing for the measurement of a base on Salisbury Plain, in consequence of resolutions taken to inclose Sedgemoor: an act for which purpose was passed a few years ago, and partly carried into execution in 1797. At this time, however, King's Sedgemoor was only set out into parochial allotments, as exhibited in Plate XXVIII. accompanying this Account. The ditches, represented by lines on this plan, were generally ten feet broad, and five feet deep; but the principal and secondary drains were much wider, the first being thirty, and the last twenty-five, feet in breadth. The subdivisions on the Moor, or the individual allotments of it, were not traced out in the Somerton quarter, at this time, the task being deferred till the latter part of the following year. The measurement, therefore, of this base, in an early part of the season, became necessary, because fewer obstacles were then expected to present themselves.

As it appeared that many instances would probably occur, in which a chain of 50 feet in length would be useful, if not absolutely necessary, one was provided by Mr. RAMSDEN, in the winter; its make and form being precisely similar to those of the larger chains, used in the measurement of our former bases. Such a chain did, indeed, prove highly serviceable in the subsequent operation; as the handles of the 100-feet chain would very often have had their places in ditches, or been so situated on their banks, as to leave imperfect means of correctly placing the register heads under the handles.

The apparatus for the measurement, consisting of the tressels

belonging to the Royal Society, pickets, iron heads, and a new set of coffers, were sent to Somerton, after Mr. GARDNER had been furnished with the means of proceeding with the survey before spoken of.

The measurement was begun in July, and finished in August; in the course of which, very little interruption arose from any inclemency of weather. It is unnecessary to enter minutely into a description of the difficulties which arose from the frequent intervention of ditches; let it suffice to observe, that, possessed of the 50-feet chain, these were rendered less material than they would otherwise have been.

When we arrived at that point which ends with the 114th chain, an *offset* was taken, and 19 chains measured, in a direction perfectly parallel to that of the base, at the extremity of which we returned into the base itself, and continued the measurement. This interruption proceeded from an accidental and unforeseen circumstance; a great ditch having been excavated in a direction coincident with that of the base, while the measurement was going on at the upper end of it. This, however, cannot be the means of introducing any sensible inaccuracy; for, to proceed in this matter correctly, when it became necessary to take an offset, a silver wire was let fall from the register head, having a plummet, under the point of which a small dot was made, on a stake driven firmly into the ground. *The great theodolite* was then placed over the stake, *and the instrument accurately adjusted over the dot.* A diaphragm, whose aperture was $\frac{1}{2}$ an inch, was then put over the object-glass of the transit telescope, which was afterwards directed towards the staff at Lugshorn Corner, and then moved round, till it exactly made a right angle with the base. The telescope being sufficiently

depressed, a peg was driven into the ground, with its centre nearly under the cross wires; after which, a pin was moved on the surface of the peg, as directed by a person looking through the telescope, till it came to that point at which it bisected the angle formed by the cross wires. The measurement was then carried on, in this new direction, a space of 19 chains, at the end of which, the same operations were repeated, and the old direction pursued. It does not seem probable, that an error amounting to more than $\frac{1}{10}$ of an inch, can have resulted from this procedure.

King's Sedgemoor being sufficiently level, the base was measured horizontally; an advantageous circumstance; but, from the soft texture of the soil, the pickets could not be driven into the ground so firmly as to be without some small degree of motion, in case a person stood close to them. Therefore, those who attended the handles of the chains, either used long stools, or placed themselves so as to divide the pressure arising from the weights of their bodies equally on each side of the pickets. The disturbances to which the register-heads were liable, did not discover themselves till a mile of the base had been measured; and, although it became probable that small errors only had resulted from the want of those precautions we afterwards followed, yet we considered what we had done as erroneous, and recommenced the measurement, with the advantage of experience. At present, I shall content myself with observing, that due attention was paid to all necessary minutiæ in this measurement, and refer those who are desirous of being more particularly informed, to the Philosophical Transactions for 1795, as the mode of proceeding on the present occasion was perfectly similar to that on Hounslow Heath.

After the conclusion of this operation, we proceeded to select such stations in the neighbourhood of the base, as might afford means of connecting it with the triangles carried on in the preceding year. The two chosen for this purpose, were Dundon Beacon, and a spot near the village of Moor Lynch; both nearer to their respective ends of the base than we wished to have found them; yet, as small rods of only an inch in diameter were placed on those stations, when they were observed from Dundon Beacon and Moor Lynch, and the same erected at the ends of the base, when they were observed from those stations, it becomes probable that very trifling errors resulted from this proceeding.

The station at Ash Beacon was visited subsequent to these just spoken of, and afterwards that on the Mendip Hills, for the purpose of taking the angle between Moor Lynch and Dundon Beacon. The operations of 1798 then terminated with a diligent search after some spot in Cornwall, for a base of only two or three miles in length: this search, however, was fruitless, as in fact we had reason to imagine it would prove to be; but we were not willing to relinquish the hope, that a piece of ground might be discovered proper for so confined a purpose. The contrary, however, being the case, the party returned to London in October.

ART. IV. *Angles taken in the Year* 1798.

At Wrotham. Station of 1787.

Between		°	′	″	Mean.
New Station and staff on Severndroog Tower	-	94	19	30	″

Station of 1798.

Severndroog Tower and Gravesend - -	62	54	36,5	}	38
			38,5		
			39,5		

At Gravesend.

Between	°	′	″	Mean.
Severndroog Tower and Wrotham	82	39	21	21
			21	
Severndroog Tower and Langdon Hill	95	53	56	59
			59,25	
		54	1,25	
Langdon Hill and Hadleigh	34	31	49,5	53
			52,5	
			54	
			57,5	
Halstow and Hadleigh	30	24	17	19
			19,75	
			20,5	
Halstow and Gad's Hill	31	38	19,75	21
			22,25	
Severndroog Tower and Hadleigh	130	25	50	50,75
			51,5	

Isle of Sheppey.

Gad's Hill and Halstow	18	18	1,5	3
			3	
			3,5	
Halstow and Hadleigh	31	28	23	24,25
			24,5	
			25	
Langdon Hill and Hadleigh	16	26	30	
Langdon Hill and Rayleigh	27	4	46	

At Halstow.

Gad's Hill and Gravesend	24	18	21,25	21,25
			21,25	
Gravesend and Hadleigh	107	49	5,25	5,25
			5,25	
Hadleigh and Sheppey	99	18	4	6
			7,5	
Gravesend and centre of Rayleigh Tower	111	20	14	
Sheppey and Rayleigh Tower	95	46	57	

At Hadleigh.

Sheppey and South End	38	43	29
Sheppey and Halstow	49	13	33,5
Gravesend and Halstow	41	46	32
Langdon Hill and Gravesend	43	11	51

Between	°	′	″	Mean.
Gravesend and Severndroog Tower	26	16	56,75 57,75	57,25
Langdon Hill and Sheppey	134	11	55	

At South End.

Sheppey and Hadleigh	119	20	5	

At Langdon Hill.

Gravesend and Severndroog	53	47	25	
Centre of Rayleigh Tower and Gravesend	122	2	46	
Station on Rayleigh Tower and centre of the same Tower	0	0	27	
Station on Rayleigh Tower and Danbury Spire	43	18	2	
Severndroog Tower and Frierning	95	25	0	
Frierning Tower and Station on Rayleigh Tower	88	44	19	
Frierning and Danbury Spire	45	26	17	
Severndroog Tower and Brentwood Spire	66	26	39	

At Triptree Heath. 1st Station.

Tillingham Tower and Station on Rayleigh Tower	68	28	58	
Tillingham and Danbury Spire	100	28	21	
Station on Rayleigh Tower and Langdon Hill	21	25	14	
Station on Rayleigh Tower and Frierning Tower	47	8	50	

At Lugshorn Corner.

Greylock's Foss and Dundon Beacon	107	44	30,75 31,25	31
Greylock's Foss and Moor Lynch	15	51	58,5 59 59,75	59
Moor Lynch and Dundon Beacon	93	52	33,75	

At Greylock's Foss.

Moor Lynch and Lugshorn Corner	114	9	58,25 59,75	59
Lugshorn Corner and Dundon Beacon	8	29	59,75 30 0,5	0
Dundon Beacon and Moor Lynch	105	40	0 0,5	0,25

Near Moor Lynch Windmill.

Between	°	′	″	Mean.
Greylock's Foss and Dundon Beacon	59	58	12,5	
Greylock's Foss and Lugshorn Corner	51	58	2,25 4,25	3,25
Lugshorn Corner and Dundon Beacon	8	0	10 10,25	10,25
Dundon Beacon and Mendip Hills	54	38	50 50	50
Mendip Hills and Ash Beacon	54	3	20 23,5 23,75	22,5
Ash Beacon and Pilsden Hill	57	19	2,5 3,75 4,5	3,5
Dundon Beacon and Pilsden Hill	56	43	36,25 36,5 37,25	36,75
Pilsden and Quantock Hills	87	15	6 7	6,5
Quantock Hills and Brent Knoll	71	38	57,75 58,5 58,5	58,25
Brent Knoll and Bleak Down	46	1	32,75 35,25 39	35,75
Bleak Down and Mendip Hills	43	41	43,5 45 45,25 46,75	45,25
Brent Knoll and Mendip Hills	89	43	19,5 20,5 24	21,25

On Dundon Beacon.

Lugshorn Corner and Moor Lynch	78	7	14,75 14,5	14,5
Lugshorn Corner and Greylock's Foss	63	45	28,5 29,5	29
Greylock's Foss and Moor Lynch	108	1	51,25 53	52,25
Moor Lynch and Bleak Down	58	42	10 10,25	10,25
Moor Lynch and Mendip Hills	101	22	54,25 55	54,5

At Ash Beacon.

Between	°	′	″	Mean.
Moor Lynch and Mendip Hills	56	29	50	
			52,25	51,5
			52,25	
Mendip Hills and Bradley Knoll	50	8	45,25	
			45,75	45,5
Bradley Knoll and Bull Barrow	93	38	10,5	
			13	12,5
			14	
Bull Barrow and Pilsden	83	40	33,5	
			35,5	34,5
Mintern Hill and Pilsden	49	21	35,75	
			39,75	38,25
			39,75	
Pilsden and Quantock Hills	59	34	40,5	
			42,25	41,5
Quantock Hills and Mendip Hills	72	57	49,75	

On the Mendip Hills.

Bradley Knoll and Ash Beacon	58	16	20	
			21,5	22
			24,25	
Ash Beacon and Moor Lynch	69	26	46,5	
			49	48,25
			49,25	
Dundon Beacon and Moor Lynch	23	58	16,5	
			17,75	17

ART. V. *Particulars relating to the Operations of the Year* 1799.

I have shewn in the preceding articles, that sufficient materials are now in my possession, for calculating the latitudes and longitudes of those places whose bearings and distances from given stations are found in the Account of 1797. I have also pointed out the direction which the survey has subsequently taken; and given a short account of the measurement of a new base in Somersetshire. The operations of 1799 now remain to be spoken of.

In very early stages of the work, I had frequent opportunities of observing, that eminent advantages would accrue to the service, were the survey prosecuted on a more extensive scale. The consideration of a grand instrument being laid up in the apartments of the Royal Society, suggested the propriety of obtaining it; therefore, when my appointment to my present situation gave me the means of effecting former ideas, I lost no time in applying to the President and Council, for the loan of their large theodolite, the excellence of which had been incontestibly demonstrated by the late Major General Roy. The distinguished services which the Royal Society have rendered this branch of the public service, leave it almost unnecessary for me to observe how readily they granted my request. The instrument was, accordingly, put into the hands of Mr. Ramsden, early in the month of January, for the purpose of being examined, and also of having new microscopes fixed to it; the former ones being much inferior, in construction, to those attached to the instrument belonging to Government.

To carry on so extensive a survey as that which is now the subject of this Paper, much consideration is necessary. I have endeavoured to give it the best effect, both as to design, and celerity of execution. What degree of success has attended my endeavours, the public, in possession of this Paper, can readily determine. In the present stage of the survey, I have been sufficiently impressed with just ideas, as to the importance of the task, and responsibility of my situation. The difficulties which start up, in prosecuting a survey of this kind, become more numerous as it becomes more extensive. In the earliest part of it, when few objects only were in view, speedy execution followed the design; but, circumstances now require every

exertion, as the triangles are branched out into several parts of the kingdom.

Were the length of a degree of the meridian, in these latitudes, accurately known, the most eligible method of carrying on the survey would be, that of working between any two determined parallels of latitude, till the space between them was completed. Yet this mode would manifestly be subject to some slight innovations, from the necessity of measuring bases in certain stages of the work: it would be right, however, to adopt the principle for general practice. Under this idea, it would have been proper to have commenced the operations of this year in Somersetshire, and to have carried on the triangles from the neighbourhood of the new base into the north of Devon.

It is mentioned in one of the former Accounts, that a zenith sector was formerly bespoken of Mr. RAMSDEN, by his Grace the Duke of RICHMOND, for the purpose of aiding the design of measuring the length of a degree of latitude in this country. The pressure of other business caused Mr. RAMSDEN to lay aside this instrument, after he had considerably advanced in its construction. The real necessity, however, for our being supplied with an instrument of this description being made known to him, he resolved to take it in hand again, and complete it. Relying on the strength of his assurances to this effect, I determined to relinquish the intention of proceeding to the westward; and resolved to commence this year's operations, with running up a series of triangles along the meridian of Blenheim. As it is probable my next communication will contain the result of this interesting part of the survey, I shall now confine myself to such particulars as relate to the subject under consideration.

In a former article, I have observed, that the chief Draftsman,

Mr. GARDNER, has been furnished with materials for surveying the northern shore of the Thames, and the north of Kent: these proved ample, as the map, thence compiled, will sufficiently demonstrate. As the Master-General issued directions, at this time, to survey Essex, and parts of the adjoining counties, in the same manner, and for the same purpose, as Kent has been, I was obliged to suspend, for a short time, my intention of proceeding with the measurement of a meridional degree, and to devise the best means for carrying his Lordship's instructions into execution.

For this purpose, therefore, before any stations were chosen in Essex, the county was very minutely examined; when it appeared, that insuperable difficulties would occur, if the survey were prosecuted with the large theodolite only. The range commencing at Havering Bower, and running to Gallywide Common, cuts off a regular communication between the stations subsequently chosen in the southern and northern parts of Essex. The difficulty resulting from this circumstance, was made still greater, from the want of success in our endeavours to find one spot on this range, proper for a station. The eastern part was, in some degree, found more favourable; but it was discovered that, even here, the small instrument must frequently be used as a substitute for the large one. Under these disadvantages, the survey commenced in March; the large theodolite being taken to a station on Hampstead Heath.

The base chosen for carrying on the distances towards the north, was that constituted by Severndroog Tower on Shooter's Hill and the new station on Hampstead Heath; which distance, although it has not, perhaps, been obtained so correctly as many others, yet is determined with sufficient accuracy for the matter

in hand. When the observations were made on Severndroog Tower, in the year 1787, the angle between Hanger Hill Tower and the cross on the dome of St. Paul's was taken: this was now made use of, in order to get the angle between Hanger Hill Tower and Hampstead Heath; because the former station could not be discovered, on account of the wind blowing the thick and darkened atmosphere of London between the stations, when the instrument this year was carried to Shooter's Hill.

For the purpose of connecting the eastern and western triangles with each other, a station was chosen on Southweald Tower, accessible only to the small instrument. Brentwood Spire was also found to be conveniently situated for carrying on the distances: this will be readily perceived by the plan. Langdon Hill was also selected; which, with the former station at Gravesend, were to become the means of connecting the triangles. A station on Epping Forest was judged necessary; but no spot could be found fit for general purposes, the view towards the north being confined. One was, however, fixed on, called Highbeech, from which a high building near Berkhamstead was found to be visible, by means of which, the distances in the north of Essex could be verified, as the station on the top of it would connect with Bushy Heath, near Watford, and a point on the elevated range near Dunstable.

From Hampstead, the instrument and portable scaffold were carried to Langdon Hill, and from thence to Triptree Heath, near Malden; from whence the party repaired to Highbeech, leaving the remainder of the county to be surveyed with the small circular instrument; which seems to have been done with considerable accuracy.

After the necessary observations were made at Highbeech, I

proceeded to Shotover Hill, in Oxfordshire; and, before May elapsed, had reconnoitred the country. As the distance between Inkpin Hill and Highclere, appeared to be shorter than was necessary for a base on which the northern triangles were to rest, it became certain, that their sides would depend on the base on Hounslow Heath. The only means by which the series now proposed to be carried westwards, (for the double purpose of forwarding the survey, and also of finding a portion of the meridional arc,) could be properly connected with the triangles in the neighbourhood of Salisbury Plain, was the side just spoken of; for the high land in the vicinity of Calne, intercepted the view of the stations on the Marlborough range, from White Horse Hill. In order, however, to make a connection, although imperfect, an intermediate station was chosen on this high intercepting land.

When the ground about Nettlebed was formerly examined by us, it appeared difficult to carry on the triangles from Bagshot Heath towards the northward; because no spot could be found near the former, from which the Chiltern range could be seen. I now, therefore, departed from the usual practice of choosing stations on the ground, and selected Pen Church Tower; by means of which, I found a connection might be made between the triangles carried round the Chiltern range, from White Horse Hill and Nuffield, with those in Hertfordshire.

At Shotover Hill the party separated, each having its instrument. I shall close this article, without entering minutely into the reasons which operated with me for the choice of all the stations selected this year. I shall content myself with enumerating the names of the stations visited and observed, and mentioning that Shotover Hill and Cumner Hill, in Oxfordshire, were selected principally with a view of ascertaining the situations of the

observatories at Oxford and Blenheim. The names of the stations were, Nuffield, White Horse Hill, and Scutchamfly, in Berkshire. Shotover Hill, Cumner Hill, Whiteham Hill, Crouch Hill, and Epwell Hill, all in Oxfordshire. Those in Gloucestershire were, Pen, Cleave, Broadway Beacon, and the Malvern Hills. The Lecky Hills, in Worcestershire. Corley and Nuneaton, in Warwickshire. Bardon Hill, Naseby Field and Barrow Hill, in Leicestershire. Arbury Hill, and Souldrop, in Northamptonshire. Quainton, Brill, Wendover, and Bow Brickhill, in Buckinghamshire. Woburn Park, and Lidlington, in Bedfordshire. Kinsworth, Lillyhoe, Berkhamstead, Tharfield, and Bushy Heath, in Hertfordshire. From the last mentioned station, the party returned to London, in October.

ART. VI. *Angles taken in the Year* 1799.

On Hampstead Heath.

Between	°	′	″	Mean.
Hanger Hill Tower and Stanmore	50	52	15,75	16,25
			17	
Highbeech and Shooter's Hill	70	6	35,5	35
			34,5	
Highbeech and St. Paul's, London	83	1	17,25	20
			22,75	
Severndroog Tower on Shooter's Hill, and Hanger Hill Tower	117	22	13	12
			11	

At Langdon Hill.

Gravesend and Severndroog Tower	53	47	25
Centre of Rayleigh Steeple and Gravesend	122	2	46
Station on Rayleigh Steeple and centre of the same	0	0	27
Station on Rayleigh Steeple and Danbury Spire	43	18	2
Severndroog Tower and Frierning Steeple	95	25	0
Frierning Steeple and Station on Rayleigh Steeple	88	14	19
Frierning Steeple and Danbury Spire	45	26	17
Severndroog Tower and Brentwood Spire	66	26	39

At Triptree Heath.

Between	°	′	″	Mean.
Tillingham Steeple and Station on Rayleigh Steeple	68	28	58	″
Tillingham Steeple and Danbury Spire	100	28	21	″
Station on Rayleigh Tower and Langdon Hill	21	25	14	″
Station on Rayleigh Tower and Frierning Steeple	47	8	50	″

At Highbeech.

Severndroog Tower and Brentwood Spire	71	16	43	44
			45	
Severndroog Tower and Southweald	44	34	27	28
			29	
Severndroog Tower and Hampstead	58	28	18	18
			18	
Cross on the Dome of St. Paul's and Hampstead	83	1	11	″
Berkhamstead Gazebo and Hampstead	138	29	57	58,5
		30	0	

At Shotover Hill.

Nuffield and White Horse Hill	81	53	27,75	28,75
			29,75	
Scutchamfly Barrow and White Horse Hill	26	8	7,75	8
			7,75	
			8,25	
White Horse Hill and Whiteham Hill	48	5	31,25	32,75
			32,75	
			33,75	
Wendover and Scutchamfly Barrow	117	30	55	56
			57,25	

On Whiteham Hill.

Shotover Hill and White Horse Hill	114	54	34,75	34,75
			34,75	
Shotover Hill and Cumner Hill	55	52	34,5	35
			35,5	
Staff over the Quadrant at Blenheim and White Horse Hill	131	25	34,5	36,5
			38,5	

On Cumner Hill.

Whiteham Hill and Shotover Hill	99	29	47	48,5
			49,5	
Shotover Hill and Atlas on the Top of the Observatory at Oxford	29	23	34	34
			34	

On White Horse Hill.

Between	°	′	″	Mean.
Nuffield and Shotover Hill	35	34	22,25	23,25
			23,75	
Nuffield and Brill	38	48	11,5	13,25
			15,25	
Scutchamfly Barrow and Shotover Hill	111	47	50	
Whiteham Hill and Staff on Blenheim Observatory	10	30	43,5	43,5
			43,5	
Brill and Stow on the Wold	64	45	42,75	43,75
			44,75	
Station near Calne and Inkpin	67	10	28,5	30,5
			32,5	
Highclere and Inkpin	12	4	11,25	11,5
			11,5	
Highclere and Nuffield	63	7	53,25	53,25
			53,5	

At Nuffield.

Bagshot Heath and Highclere	78	17	16,5	18,25
			17,75	
			18,75	
			19,75	
Highclere and White Horse Hill	53	33	49,5	49,5
			49,75	
White Horse Hill and Shotover Hill	62	32	3,5	5,25
			4,5	
			6,5	
			7	
White Horse Hill and Brill	86	4	15,75	16,25
			16	
			17	

On Scutchamfly Barrow.

White Horse Hill and Shotover Hill	111	47	50	
Shotover Hill and Wendover	34	26	50	52
			50,75	
			52,75	
			54,5	

At Stow on the Wold.

Cleave and Broadway Beacon	54	44	54,5	55,75
			54,5	
			57	
			57	

Between	°	′	″	Mean.
Broadway Beacon and Epwell	72	38	48,5	
			49	49,5
			50,5	
Epwell and Brill	60	56	6	
			6,5	6,25
White Horse Hill and Cleave	109	40	36,25	
			36,75	
			37	37
			37,75	

At Broadway Beacon.

Epwell and Stow	69	10	30,75	
			31,5	31,75
			32,75	
Stow and Cleave	78	53	6	
			8	7,75
			9,5	
Cleave and Malvern Hills	60	28	12,5	
			17,75	16
			18	
Malvern and Lecky Hills	53	53	19¼	
			20	19,75

At Epwell.

Stow and Broadway Beacon	38	10	43,25	
			43,5	
			44	44
			44,25	
			44,5	
Stow and Brill	86	29	13	
			13,5	13,5
			13,75	
Brill and Arbury Hill	85	0	16,5	
			20,5	18,5
Arbury Hill and Corley	54	55	17, 5	
			19	18,75
			20,25	

At Corley.

Bardon Hill and Nuneaton Common	49	54	50,75	
			53	51,75
Nuneaton and Arbury Hill	110	20	52	
			52,5	
			52,75	52,75
			53	

Between	°	′	″	Mean
Arbury Hill and Epwell	35	17	34,75	"
			35,75	
			36,25	36,75
			36,75	
			38	
			39,25	
Epwell and Broadway Beacon	28	2	46,75	
			50	49,75
			53	
Nuneaton and Lecky Hills	133	25	11,5	
			11,5	11,5
Nuneaton and Station near Birmingham	49	54	50,75	
			53	52

At Arbury Hill.

Quainton and Brill	16	12	37,25	
			37,5	
			40,5	40
			42,5	
			42,75	
Brill and Epwell	60	35	43	
			43,25	
			44,5	
			45	45,5
			46,5	
			48,5	
			48,5	

Near Brill on the Hill.

White Horse Hill and Stow	50	14	44	
			44,5	44,5
			44,75	
Nuffield and White Horse Hill	55	7	33	
			34	33,5
Stow and Epwell	32	34	42,5	
			43,5	
			43	43
			43,25	
Epwell and Arbury Hill	34	23	58,5	
			58,75	58,5
Arbury Hill and Bow Brickhill	68	20	7,75	
Bow Brickhill and Wendover	57	25	1	
			2	1,5
Wendover and Shotover Hill	108	5	22	
			23,5	22,75
Quainton and Wendover	51	34	33,25	
			32,75	33

Near Wendover.

Scutchamfly Barrow and Shotover Hill	28	2	12,75	

Between	°	′	″		Mean.
Brill and Quainton	33	26	48	}	48″
			48		
			48,25		
Brill and Bow Brickhill	80	11	8,25	}	9,25
			10,25		
Brill and Shotover Hill	23	23	56,25	}	57,5
			58,75		
Bow Brickhill and Stanmore	102	22	29		
Pen Tower and Stanmore	38	13	16,25	}	18
			19,75		
Near Quainton.					
Bow Brickhill and Wendover	94	23	49,25	}	50,25
			51,25		
Wendover and Brill	94	58	36	}	37
			38		
At Bow Brickhill.					
Brill and Arbury Hill	68	22	55,5		
			55,75	}	56,75
			57,5		
			58,75		
Brill and Wendover	42	23	50,5	}	50,75
			51		
Wendover and Kinsworth	46	18	4,25		
			5,75	}	8,25
			9,25		
			14		
Kinsworth and Quainton	85	9	52,75	}	52,75
			53,75		
Kinsworth and Lillyhoe	42	10	33,25		
			38,5	}	36,75
			39		
Kinsworth and Lidlington	80	39	37,25		
Trusler Hill and Lillyhoe	14	54	38,75		
			43,5	}	42,5
			45,5		
Trusler Hill and Arbury Hill	45	49	41,75	}	43
			44		
At Kinsworth.					
Brill and Bow Brickhill	62	55	35,25		
			38,5	}	38,75
			39		
			42		
Quainton and Bow Brickhill	52	17	56,25		
			57,25	}	56,75
			57		

Between	°	′	″	Mean.
Bow Brickhill and Lillyhoe	82	50	26	
			30	30,5
			35	
Lillyhoe and Tharfield Tower	12	12	39,75	
			42	40,75
Tharfield and Station on Gazebo at Berkhamstead	50	2	55,5	
			56	
		3	0,5	53,25
			1	
Stanmore and Berkhamstead	41	15	56,5	
			57,75	57,25
Bow Brickhill and Stanmore	173	37	43	
			45	44

Near Lillyhoe.

Bow Brickhill and Kinsworth	54	58	52,5	
			52,5	
			52,5	53
			53,75	
Lidlington and Bow Brickhill	23	59	30	
			32	31
Bow Brickhill and Trusler Hill	5	52	11,5	
Station on the Ground near Tharfield Tower and Kinsworth	166	4	44,5	
			48	46,25

At Lidlington.

Kinsworth and Bow Brickhill	68	16	19	
			22,75	22,25
			25,25	

At Crouch Hill.

Brill and Epwell	145	23	25,75	
			27	26,25

At Stanmore.

Wendover and Kinsworth	37	41	39,25	
			43	41
Pen Tower and Wendover	23	4	47,5	
			47,5	
			47,75	48,5
			49,25	
			49,25	
Bagshot and Pen Tower	49	32	29,5	
Bagshot Heath and Hanger Hill Tower	59	55	54,25	
			53,75	54

Between	°	′	″	Mean.
Hampstead Heath and Hanger Hill Tower - -	45	25	51	51,75
			51,5	
			51,5	
			52,75	
On Busby Heath.				
Wendover and Kinsworth - - -	38	22	5	6,75
			8,5	
On Bagshot Heath. Station of 1794.				
Highclere and Nuffield - - -	55	32	25,5	26
			25,75	
			26,75	
Nuffield and Pen Tower - - -	48	47	11	12,5
			12,75	
			12,75	
Pen Tower and St. Ann's Hill - - -	70	30	37,25	39,25
			39	
			40	

ART. 7. *Situations of the Stations.*

Trevose Head. The station on this point of land, which is about four miles from Padstow, in Cornwall, is situated on the southern part of it, and is about forty feet from the declivity. The ground seems a little higher than any other part of the Head.

Cadon Barrow. The station is on the centre of the Barrow; which is a very remarkable one, and well known about the country. It is about two miles from Tintagel, being in a field lying south of the road leading from that town to Camelford.

Brown Willy. The staff is erected on the highest part of this mountain, which is about nine miles southward of Camelford.

St. Stephen's Down. The station is about 150 feet from the eastern part of the building erected on this Down. It lies south-west from the corner of it, and about twenty feet from the road.

Mendip. The station is in a field on the top of the down, being about two miles north of *Shepton Mallet.* The field is next to the road leading from that place to Bristol, and lies west of it: it is also north of the road which goes from Wells to Frome.

This road crosses the former at right angles. The station is 20 feet north of the southern hedge, and about 200 from the eastern one. The ground round the station is rather higher than any other part of the field.

Dundry. The station is on the down, close to, but west of, the town so called. The down is full of holes and pits, from which stones have been taken for the purposes of building. The station, however, may easily be found, as it is situated on a rising which has the appearance of having been a barrow.

Lansdown. This place is well known, and near Bath. The station is on the highest part of the broken ground called CROMWELL'S *Camp*, which is near Mr. GRANVILLE'S monument.

Farley Down. The station on this Down is 5 feet north of the stone wall, and about 150 feet eastward of the plantation.

Bradley Knoll. This is a remarkable hill, very near Maiden Bradley. The highest part of the hill is towards the west, on which there is a small ring, exhibiting an appearance of a ruined plantation. The station is a few feet to the northward of this ring.

Westbury Down. There are no objects on this Down, of any kind; therefore, the station cannot be found from measurements. It is, however, just above the *White horse* cut out in the side of the hill.

Ash Beacon. This eminence is about four miles north of Sherborne: on the top of it there is a small plantation, round which is a circular wall. The station is 85 feet east of it.

Dundon Beacon. This is an insulated hill, at the eastern extremity of King's Sedgemoor; upon it are the remains of a barrow, probably the site of the ancient beacon. The station is about 4 feet eastward of the small cavity in the centre of it.

Lugsborn Corner, the eastern extremity of King's Sedgemoor. There is a small rivulet, which separates the moor from the cultivated ground on the Somerton side, and, close to a particular part of it, is a passage called *Somerton Gate*. About a quarter of a mile eastward of this entrance, and in the second field, north of the stream, is the station called *Lugsborn Corner*, one of the ends of the base. The spot is 5 feet from the ditch, and 19 from the gateway. There were but three fields in this part of the moor, at the time the base was measured.

Greylock's Foss. This is towards the western extremity of the moor: a causeway leads from *Middlezoy* to *Greinton*, over it. In the second field from the bridge, near the latter, is the other extremity of the base. The station is about 10 feet from the ditch, running parallel to the Foss, and is in the angle formed by the ditch contiguous to the road and the second ditch north of the drain.

Nuffield. The station is in the field opposite to the church: it is in the south-west corner of it, 14 feet from the *stile*, and 10 feet from the hedge.

Scutchamfly. A very remarkable Barrow, on the Berkshire downs, situated near Little Hendred. The station is on the south-west part of it, and can easily be found.

White Horse Hill. This is a well known eminence in Berkshire. The station is on the eastern side of the Saxon work, and on the top of the small parapet surrounding the ditch.

Shotover Hill, near Oxford. The station is 150 feet from the hedge eastward of it, and 60 feet from that southward of it; but, when the traces of our former operations are obliterated, it will be difficult to recover this station.

Stow on the Wold. The station bearing this name, is in a

field 2 miles eastward of the town: it lies on the north side of the road leading from Stow to Burford, and may be easily distinguished, being that particular field which affords the most commanding view. The station is 32 feet west of the corner of the hedge which forms a right angle with another abruptly running out: it is also 279 feet from the ridge which divides the field.

Broadway Beacon. This is a very high and remarkable spot, near the village of Broadway, in Gloucestershire. The station is about 20 feet south-east of the foundation of a building proposed to be erected by the Earl of COVENTRY.

Corley, a village in Warwickshire. The station is in the second field eastward of the church, being 180 feet from the eastern hedge, and 230 feet from the stile in the corner of it.

Epwell, a village in Oxfordshire. The station is on the apex of the hill, and may easily be found, by measuring 17 feet from the stile, and 14 feet from the hedge which runs across the hill. N. B. The station is west of the hedge.

Brill on the Hill, Buckinghamshire. The station is on *Muzzle Hill*, near the town. There is but one field on this hill: it is on the highest part of it. The station is situated in the centre of the field, and in the middle of a rising, once the site of a windmill.

Arbury Hill. This hill is still surrounded with the remains of an ancient fortification. The station is on the north-west corner of it, and near the brow, but cannot be easily found, from the want of proper objects to which measurements may be made.

Wendover, Buckinghamshire. The station is on the down south of the town, and contiguous to the village of Ellesborough. A road from Wendover, to Sir JOHN RUSSELL's seat, Checquers, runs over the down: but, as there are no marks on it, its pre-

cise situation cannot be easily pointed out by measurement. It may, however, be observed, that it is 14 feet southwards, from the decayed parapet on the top of the hill.

Quainton, Buckinghamshire. The station is on the high ground, north of this town. It cannot very easily be found, because the hill is destitute of objects; yet it may, probably, be discovered, by looking for it on the *green ridge* which divides the land: it is in the middle of that boundary, and about 200 feet westward of the pathway.

Kinsworth, a village near Dunstable. The station is on the summit of a hill, about half a mile north of the village. A hedge runs across the hill, from which the station is 40 feet north-west: it is likewise *close* to the road.

Lillyboe, Hertfordshire. The station is on a commanding eminence, having the *Icknield way* at the foot of it. There are no objects on this hill, therefore the precise situation cannot be pointed out by means of measurement: it is towards the north-west corner of the hill.

Stanmore. This station is on the southern extremity of the range above the town: it is near the trees, and a little to the westward of the broken ground.

Busby Heath, near Stanmore. The station cannot be easily found: it is about 1000 feet from the road, but there are no objects near enough to determine it by measurement.

Wrotham. This station is 203½ feet north-east of the old station: it may be easily found, with the assistance of a theodolite, Severndroog Tower making an angle of 94° 19′ with the new station.

Gravesend. The station is on Windmill Hill, and on the western side of it: it is about 50 feet south of the stile, and near the brow.

Gad's Hill, Kent. The station is very easily found, being in the middle of the *tumulus*.

Sheppey, Isle of. The station is on the bare hill, westward of, and contiguous to, the high range: it cannot be found through means of measurement.

Hampstead. The station is on the heath, but cannot easily be found, on account of the rugged and broken ground which surrounds it: it is situated 40 feet from the road, and among the sand holes.

Langdon Hill, Essex. The station is in the middle of the field on the top of this hill: it is about 400 feet from either of the stiles.

Hadleigh. The station is on a remarkable hill, in shape very like a barrow, and is about a mile south-west of the town.

Southend. The station is in the second field westward from the terrace: it cannot be easily found.

Interior Stations.

Hope's Nose, the north projecting point of Torbay. The only spot fit for a station in this part is the one chosen: it can easily be found, for it is the high and bare rising, just above the Nose.

Ball's Obelisk. This object is on the eastern part of Great Haldon, in Devonshire. The station can be easily found, for it is close to the gate of the inclosure, and on the only spot not covered with heath.

Evercrutch, in Somersetshire. The hill on which the station is, commands an extensive view, and is not far from the town of Evercrutch. Bruton is also near it. The station is in the middle of the flat place on the top of the hill.

Crouch Hill, near Banbury, in Oxfordshire. The hill is well

known, and the station easily found; for the apex of the hill appears as if it were truncated, and in the middle of the smooth part is the station.

Cumner Hill, near Oxford. The station is about 130 feet westward from the centre of the clump of trees.

Whiteham Hill, Oxfordshire. There are a few trees contiguous to the station, which bear eastward from it, and are about 80 feet distant. The station is on the highest and smoothest part of the hill.

Lidlington, a village near Ampthill in Bedfordshire. This station can easily be found, for a tumulus, whose centre is the station, has been erected, to render it conspicuous.

Trusler Hill, in Woburn Park. The station is on a tumulus likewise; and can be found without any difficulty.

Stations in Essex, Suffolk, and Hertfordshire.

Prittlewell Steeple.

Rayleigh Steeple. The station is in the north-east corner, 20 inches from the north parapet, and 4 feet from the eastern one.

Danbury Steeple. The instrument was placed in the four angles of the Steeple, as circumstances rendered it necessary. The points are readily found, as there is scarcely room in the corners to place an instrument. Stations were also selected on the following Steeples, &c.

Canewden Steeple.	West Mersea St.	Little Bentley St.
Frierning St.	Colchester, St. Mary's Staircase.	Woodbridge St.
Tillingham St.	Tattingstone St.	Butely St.
Thorp St.	Rushmere St.	Otley St.
Stoke St.	Great Tey St.	Henley St.
Dover Court St.	St. Osyth Priory, Flagstaff.	Falkenham St.
Peldon St.	Shoebury Ness, Staff.	Copdock St.

Naughton St.	Beauchamp Roding St.	Westham St.
Lavenham St.	Hornchurch St.	Barking, Staircase.
Bulmer St.	Naseing St.	Berkhampstead, Gazebo.
Glemsford St.	Henham on the Mount St.	
Toppesfield St.	Thorley St.	Gallywood Common.
Twinestead St.	Albury St.	Purfleet Cliff.
Southweald St.	Elmdon St.	Babraham Mount.
Pleshley St.	Rickling St.	Epping Mill, Base.
High Easter St.	Thaxted St.	Brentwood Spire, surveyed round.
HatfieldBroad Oak St.	Balsham St.	

Stations in Kent.

Frant Steeple. Station of 1787.	Seal Chart.	Ash St.
Botley Hill. Do.	Tunbridge St.	North Fleet St.
Chiddingstone St.	Oxford Mount.	Stockbury St.
Mount Sion.	Silverden Farm.	Hernhill St.
East Peckham St.	Well Hill.	
Tudely St.	Crayford St.	

The stations chosen for the survey of Essex, and parts of the adjoining counties, as also for completing the survey of Kent, are mostly towers, as may be seen from the above. When the tops of the towers have been smooth and even, the stations were always in the centres of them; but, when they were covered with roofs, or had spires upon them, stations were chosen in the most convenient places, and staffs always erected. I have omitted giving the measurements by which the stations may be exactly found, Rayleigh and Prittlewell excepted, in order to avoid swelling this article to an inconvenient length.

ART. VIII. *Particulars relating to the Base on King's Sedgemoor, and the Reduction of that Base.* Plate XXVIII.

Comparisons of the Chains.

As the chains, after the measurement on Salisbury Plain, were oiled, and laid up in the Tower, no apprehensions were entertained that either of them was elongated by the rusting of the joints. It was, however, our wish to have compared them with each other, previous to the commencement of this operation, and attempts were made, but rendered unsatisfactory, from the want of sufficient firmness in the soil. It was not till we arrived at the 70th chain, that a good opportunity presented itself: the measuring chain A, was then compared with the standard B, and found to be thirteen divisions of the micrometer head, attached to the brass scale, in excess. In these trials, the temperature remained constant; the mercury in FAHRENHEIT's thermometer being at $66\frac{1}{2}°$.

The 50-feet chain, spoken of in a former article, came from the hands of Mr. RAMSDEN without being very accurately measured; therefore it now became proper to ascertain its length, by means of the standard chain. This was accordingly done at the present time; when B was found to exceed twice the length of the 50-feet chain, by 14 divisions of the micrometer screw; the thermometer, at the time of trial, standing at $69\frac{1}{2}°$.

At the conclusion of the measurement, the chains were again compared, when the working chain A, was found to exceed the standard, $17\frac{1}{4}$ divisions on the micrometer head: this was after 273 chains were measured. Now, when 70 chains only had been measured, the difference between A and B was 13 of those

divisions; consequently $17\frac{1}{4} - 13 = 4\frac{1}{4}$ divisions, was the wear of B, in measuring 203 chains. Therefore, the whole wear is found by this proportion, *viz.* $203 : 4\frac{1}{4} :: 273 : 5{,}223$ divisions, $= \frac{3}{100}$ of an inch; which very inconsiderable quantity, like the wear on Salisbury Plain, no doubt, arose from the pivots and pivot holes of the joints being polished by continual use. This supposition seems just; as the wear of the chain, after the measurement on Hounslow Heath, was found to be much greater.

The length of the chain A, as well as that of the standard B, was accurately ascertained by Mr. RAMSDEN, in the year 1793, as particularly shewn in the Philosophical Transactions for 1795. In the temperature of 54°, A was found to exceed 100 feet, $\frac{114285}{1000000}$ of an inch; therefore, adding the wear which took place on Salisbury Plain, *viz.* $\frac{1}{200}$ part of an inch, we get the length of A at the commencement of the measurement on Sedgemoor = 100,01009 feet.

From repeated trials, as before observed, the standard B was found to exceed the length of twice that of the new fifty-feet chain, 14 divisions of the micrometer head; and, *after* the measurement, the same chain fell short of A, $17\frac{1}{4}$ of those divisions: hence, A exceeds twice the length of the 50-feet chain, $31\frac{1}{4}$ divisions. Therefore the length of the short chain, in the temperature of 54°, may be taken at 50,00075 feet.

ART. IX. *Table of the Measurement of the Base of Verification on King's Sedgemoor.*

Days.	Spaces measured. Yards.	Mean temp. by 15 therm.	Days.	Spaces measured. Yards.	Mean temp. by 15 therm.	Days.	Spaces measured. Yards.	Mean temp. by 15 therm.
July	100	69,7		3200	79,27	6	6300	92,26
	200	65,56		3300	79,96		6400	86,73
11	300	62,73	25	3400	62,06		6500	68,30
	400	67,40		3500	65,90	7	6600	82,06
	500	64,10	26	3600	67,63		6700	91,06
12	600	65,30		3700	65,83		6800	89,76
	700	73,40	27	3800	67,72		6900	93,43
	800	69,36		3900	75,53	8	7000	75,94
	900	68,06		4000	71,40		7100	81,57
13	1000	66,05		4100	71,23		7200	81,93
	1100	70,30		4200	67,14		7300	79,36
	1200	69,33	31	4300	66,56		7400	68,20
	1300	62,83	Aug. 1	4400	71,16	9	7500	78,18
14	1400	63,93	2	4500	64,60		7600	76,50
	1500	61,40		4600	65,16		7700	71,26
	1600	57,03		4700	68,16		7800	72,13
16	1700	66,36		4800	70,16		7900	70,8
	1800	65,80		4900	76,23	13	8000	71,5
	1900	71,03		5000	70,66		8100	8,4
17	2000	75,70		5100	64,23		8200	84,53
	2100	80,43	3	5200	64,46		8300	76,13
	2200	77,53		5300	63,96		8400	69,56
18	2300	65,96		5400	63,86		8500	66,03
	2400	69,79		5500	67,13	14	8600	85,53
	2500	69,56	4	5600	78,53		8700	83,73
	2600	68,16		5700	73,84		8800	85,87
19	2700	68,19		5800	69,83		8900	78,46
	2800	72,66		5900	65,86		9000	78,36
	2900	69,23		6000	61,50	15	9100	73,77
21	3000	70,76		6100	76,46	16	9225,4943	63,00
	3100	79,68		6200	84,26			

ART. X. *Reduction of the Base.*

	Feet.
The overplus of the 273d chain was measured by Mr. RAMSDEN, and found to be 23,517 feet; wherefore, the apparent length of the base was -	27676,4830
From the measurement in the Riding-house of his Grace the Duke of MARLBOROUGH, the chain A was found to exceed 100 feet, in the temperature of 54°, 0,11425 parts of an inch; to which, adding the wear by the measurement on Salisbury Plain, *viz.* $\frac{1}{200}$, and also *half* the wear by the measurement of this base, *viz.* $\frac{1}{100}$ part of an inch, we get $\frac{0,1191}{12}$ for the excess of the chain's length above 100 feet; therefore, $\frac{0,1191}{12} \times 272,8 = 2,7075$ feet; which add - - - -	+2,7075
The sum of all the degrees shewn by the thermometer was 98511; wherefore, $\frac{98511}{5} - 54^\circ \times 272,8 \times \frac{0,0075}{12} = 3,1069$ feet; which also add -	+3,1069
Again, from the comparison of the 50-feet chain with the standard B, it appeared that the excess above 50 feet, in the temperature of 54°, was 0,09075 parts of an inch; therefore, $\frac{0,09075}{12} \times 8 = 0,0605$ parts of a foot. This likewise add -	+0,0605
The sum of all the degrees shewn by the thermometers placed by the sides of the 50-feet chain, was 1372; therefore $\frac{1372}{5} - 54^\circ \times 4 \times \frac{,0075}{12} = 0,0365$ parts of a foot: and this add - -	+0,0365
	27682,3944

27682,3944

And, for the reduction of the base to the temperature of 62°, *viz.* for 8° on the brass scale, we have $\frac{0,01237 \times 272,8 \times 8^{\circ}}{12} = 2,2497$ feet; which subtract —2,2497

Therefore, the length of the base is - - - feet 27680,1447 which, neglecting decimals, may be taken at 27680 feet.

As to the probable error of the above conclusion, I know not how to form a just opinion. On ground sufficiently hard, and otherwise favourable, I think a base of 5 miles might be measured so accurately, as to afford a result not differing from the truth more than three inches: but, on this occasion, I should not suppose the error can be less than six, nor more than nine inches. Motives for adopting this supposition, have been related in a foregoing article.

ART. XI. *Calculation of the Sides of certain principal Triangles in Cornwall and Devonshire.* Plate XXVII.

Distance from Hensbarrow to St. Agnes Beacon, 97084,8 Feet. Phil. Trans. 1797. p. 461.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
1.	St. Agnes Beacon	47 10 0,75	—0,15			47 10 3,25	
	Hensbarrow - -	67 6 13,25	—0,58			67 6 13	
	Trevose Head -	65 43 47	—0,57			65 43 43,75	
		180 0 1		1,31	—0,31		
	Trevose Head from	St. Agnes Beacon -					98108,1
		Hensbarrow - -					78099,9

Distance from Hensbarrow to Bodmin Down, 47337,2 Feet. Phil. Trans. 1797. p. 460.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
II.	Hensbarrow - -	77 20 18,5	—0,30			77 20 17,5	
	Bodmin Down -	68 21 58,25	—0,32			68 21 57,25	
	Trevose Head -	34 17 45,5	—0,23			34 17 45,25	
		180 0 2,25		0,86	+1,39		
	Trevose Head from { Bodmin Down - -						81967,6
	Trevose Head from { Hensbarrow - -						78093

Mean distance from Hensbarrow to Trevose Head, 78096,4 feet.

III.	Trevose Head -	42 33 52	—0,32			42 33 51,25	
	Bodmin Down -	71 55 27	—0,43			71 55 26,75	
	Cadon Barrow -	. . .				65 30 42,0	
	Cadon Barrow from { Trevose Head - -						85625
	Cadon Barrow from { Bodmin Down - -						60925
IV.	Bodmin Down -	30 58 13	—0,05			30 58 12,75	
	Cadon Barrow - -	43 49 50,5	—0,04			43 49 50	
	Brown Willy - -	. . .				105 11 57,25	
	Brown Willy from { Bodmin Down - -						43722
	Brown Willy from { Cadon Barrow - -						32488

Distance from Carraton Hill to Maker Heights, 82600,3 feet. Phil. Trans. 1797. p. 458.

V.	Carraton Hill - -	74 5 22,5	—0,60			74 5 21,75	
	Maker Heights -	53 4 29	—0,48			53 4 28,75	
	Black Down - -	52 50 9,75	—0,48			52 50 9,5	
		180 0 1,25		1,57	—0,32		
	Black Down from { Maker Heights - -						99680
	Black Down from { Carraton Hill - -						82860,4

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
VI.	Carraton Hill - -	48 57 8,25	−0,24			48 57 9,25	
	Black Down - -	39 44 39	−0,22			39 44 38,5	
	St. Stephen's Down	91 18 12,75				91 18 12,25	
		180 0 0		0,89	−0,89		
	St. Stephen's Down from { Carraton Hill - -						52991,3
	St. Stephen's Down from { Black Down - -						62506,7

Distance from Carraton Hill to Kit Hill, 33427 feet. Phil. Trans. 1797. p. 459.

VII.	Carraton Hill - -	70 15 32	−0,14			70 15 32,25	
	St. Stephen's Down	37 1 56	−0,11			37 1 55,75	
	Kit Hill - -	. . .				72 42 32	
	St. Stephen's Down from { Carraton Hill - -						52994
	St. Stephen's Down from { Kit Hill - - -						52240,4

Mean distance from St. Stephen's Down to Carraton Hill, 52292,7 feet.

VIII.	St. Stephen's Down	54 16 13	−0,19			54 16 12,5	
	Black Down - -	52 57 37	−0,19			52 57 36,5	
	Kit Hill - -	. . .				72 46 11	
	Black Down from { Kit Hill - - -						53128
	Black Down from { St. Stephen's Down -						62509,2

Hence the mean distance from Black Down to St. Stephen's Down, is 62508 feet.

In the third triangle, the angle at Cadon Barrow is supplementary. When the observations were made at that station, a direction-post at Bodmin Down was mistaken for the staff, (to which it was similar in shape,) erected at no great distance from it. This error was not detected till long after: and, although it has been a maxim to which we have generally adhered, of observing all the angles of

each triangle, yet, for the reasons assigned in the preface, I have chosen to depart from it on the present occasion. In another principal triangle, the angle at Brown Willy is also supplementary: it has already been mentioned, that an instrument cannot be got on the top of it. As to the angles at Kit Hill, in the two last triangles, being inferred ones, it may be proper to mention, that Black Down was chosen for a station, after the observations were made at the former. To have visited Kit Hill a second time would have been unnecessary, because there are not any distances, except to interior objects, which depend upon those triangles.

ART. XII. *Calculation of the Sides of a Set of principal Triangles, carried on from the Side which joins the Stations on Beacon Hill, near Amesbury, and Wingreen Hill, near Shaftsbury, towards the Base of Verification on King's Sedgemoor.* Plate XXIX.

Distance from Beacon Hill to Wingreen Hill, 114522,4 Feet. Phil. Trans. 1795, p. 501.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
IX.	Wingreen Hill	89 57 37,75	−0,97			89 57 37	
	Beacon Hill	32 11 43,25	−0,48			32 11 43	
	Bradley Knoll	57 50 38,25	−0,48			57 50 40	
		179 59 59,25		1,93	−2,68		
	Bradley Knoll from Wingreen						72074
	Bradley Knoll from Beacon Hill						135272,3
X.	Bradley Knoll	40 43 52	−0,26			40 43 51,5	
	Wingreen	96 20 37	−0,65			96 20 36,25	
	Bull Barrow	42 55 32,75	−0,25			42 55 32,25	
		180 0 1,75		1,16	+0,55		
	Bull Barrow from Bradley Knoll						105180
	Bull Barrow from Wingreen						69053,6

In the Philosophical Transactions for 1797, p. 455, the distance from Bull Barrow to Wingreen is said to be 69058, being 4½ feet greater than the above conclusion.

No of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XI.	Bull Barrow	40 38 47,75	—0,28			40 38 45,25	
	Bradley Knoll	45 43 3,5	—0,28			45 43 3,25	
	Ash Beacon	93 38 12,5	—0,65			93 38 11,5	
		180 0 3,75		1,25	+2,50		
	Ash Beacon from { Bradley Knoll						68650,6
	Ash Beacon from { Bull Barrow						75451
XII.	Beacon Hill	23 4 15	—0,08			23 4 14,75	
	Bradley Knoll	42 43 29,75	+0,07			42 43 28,25	
	Westbury Down	114 12 18,5	—0,97			114 12 17	
		180 0 3,25		1,17	+2,08		
	Westbury Down from { Beacon Hill						100625,1
	Westbury Down from { Bradley Knoll						58118,2
XIII.	Westbury Down	40 48 1,75	—0,12			40 48 1,75	
	Bradley Knoll	101 23 59	—0,48			101 23 59,75	
	Mendip Hills	37 47 58,5	—0,16			37 47 58,5	
		179 59 59,25		0,77	+1,52		
	Mendip Hills from { Westbury Down						92954,0
	Mendip Hills from { Bradley Knoll						61961,1

Base of verification.—Greylock's Foss to Lugshorn Corner, 27680 feet.

XIV.	Lugshorn Corner	107 44 31				107 44 31	
	Greylock's Foss	8 30 0				8 30 0	
	Dundon Beacon	63 45 29				63 45 29	
		180 0 0			0		
	Dundon Beacon from { Lugshorn Corner						4561,5
	Dundon Beacon from { Greylock's Foss						29393

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
xv.	Greylock's Foss -	105 40 0,25				105 40 0,5	
	Moor Lynch -	59 58 14				59 58 14,5	
	Dundon -	14 21 44,75				14 21 45	
		179 59 59			−1,0		
	Moor Lynch from { Greylock's Foss -						8421,5
	Moor Lynch from { Dundon Beacon -						32688,7
xvi.	Lugshorn Corner -	13 51 59				13 51 58,75	
	Greylock's Foss -	114 9 59				114 9 58,5	
	Moor Lynch -	51 58 3,25				51 58 2,75	
		180 0 1,25			+1,25		
	Moor Lynch from { Lugshorn Corner -						32061,3
	Moor Lynch from { Greylock's Foss -						8421,8
xvii.	Lugshorn Corner -	93 52 33,75				93 52 34,25	
	Moor Lynch -	8 0 10,25				8 0 10,75	
	Dundon Beacon -	78 7 14,5				78 7 15	
		179 59 58,5			−1,5		
	Dundon Beacon from { Lugshorn Corner -						4561,5
	Dundon Beacon from { Moor Lynch -						32689,0

Hence the mean distance from Moor Lynch to Dundon Beacon is 32688,85 feet.

xviii.	Moor Lynch -	54 38 50	−0,07			54 38 49,5	
	Dundon Beacon -	101 22 54,5	−0,32			101 22 53,75	
	Mendip Hills -	23 58 17	−0,10			23 58 16,75	
		180 0 1,5		0,5	+1,0		
	Mendip Hills from { Moor Lynch - -						78876,8
	Mendip Hills from { Dundon Beacon -						65622,7

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XIX.	Moor Lynch -	54 3 22,5	—0,42			54 3 22	
	Mendip Hills -	69 26 48,25	—0,49			69 26 47	
	Ash Beacon -	56 29 51,5	—0,42			56 29 51	
		180 0 2,25		1,33	+0,92		
	Ash Beacon from { Moor Lynch - -						88571
	Ash Beacon from { Mendip Hills -						76851
XX.	Mendip Hills -	58 16 22	—0,30			58 16 21,5	
	Ash Beacon -	50 8 45,5	—0,28			50 8 45,25	
	Bradley Knoll -	71 34 55	—0,36			71 34 54,25	
		180 0 2,5		0,95	+1,55		
	Bradley Knoll from { Mendip Hills -						61963,5
	Bradley Knoll from { Ash Beacon - -						68653,6

The distance from Bradley Knoll to the station on Mendip Hills, and also to that on Ash Beacon, is given in the preceding triangles, independent of the above values. The first is 61961,1, and the second 68650,6 feet: these distances have their origin in the base on Salisbury Plain. The other distances are 61963,5, and 68653,6 feet; and these depend on the base of verification on King's Sedgemoor. There is, therefore, a difference of $2\frac{4}{10}$ feet between the values of one distance, (12 miles nearly,) and 3 feet between those of the other, which is about 13 miles in length. If the computations had been carried on from one base to another, the difference between the measured base on Sedgemoor and the computed base, would have appeared to be *one foot nearly*. I have already delivered it as my opinion, that an error of nine inches may exist in the new base: therefore, these results must be considered as satisfactory enough. A different correction of the observed angles, or another selection of

the angles themselves, might afford a closer agreement; but I can see no just reason for making any alterations in one or the other. I shall now take the means of the distances, as derived from both bases, and consider 68652,2 feet as the true distance from Ash Beacon to Bradley Knoll; and 61962,3 feet for that between Bradley Knoll and the station on Mendip Hills.

In one of the foregoing triangles, (Bull Barrow, Bradley Knoll, and Ash Beacon,) the distance between Ash Beacon and Bull Barrow is found to be 75451 feet. If the *mean distance* between Bradley Knoll and Ash Beacon, *viz.* 61962,3 feet, be now used, 75452,7 feet becomes the distance between those stations; and this I shall use, in computing the sides of the two triangles which immediately follow.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XXI.	Ash Beacon	34 18 56,25	−0,14			34 18 55,75	
	Bull Barrow	51 26 42	−0,13			51 26 41,75	
	Mintern	94 14 23	−0,32			94 14 22,5	
		180 0 1,25		0,59	+0,66		
	Mintern from { Ash Beacon						59166,6
	Mintern from { Bull Barrow						42653,7
XXII.	Pilsden	35 3 1	−0,24			35 3 0,75	
	Ash Beacon	49 21 38,25	−0,24			49 21 38	
	Mintern	95 35 22	−0,60			95 35 21,25	
		180 0 1,25		1,08	+0,17		
	Pilsden from { Ash Beacon						102535
	Pilsden from { Mintern						78177,6

In our last account, (see Phil. Trans. 1797. p. 455 and 456,) the distance from Bull Barrow to Mintern was found to be 42653,4 feet; and the distance from Pilsden to Mintern 78177 feet. The distances derived from the above triangles are very nearly the same; a difference of a few inches only existing between them.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	′	° ′ ″	Feet.
XXIII.	Moor Lynch -	57 19 3,5	−0,64			57 19 2,5	
	Ash Beacon -	76 2 30,5	−0,39			76 2 36	
	Pilsden - -	. . .				46 38 21,5	
	Pilsden from Moor Lynch - -						118230

But Pilsden was also observed from Dundon Beacon; from which, and the angle observed at Moor Lynch, between Dundon Beacon and Pilsden, results the following triangle.

XXIV.	Moor Lynch - -	56 43 36,75	+0,03			56 43 36,5	
	Dundon Beacon -	108 1 52	−0,64			108 1 51,75	
	Pilsden - -	. . .				15 14 31,75	
	Pilsden from Moor Lynch - - - -						118233,6

Hence, the mean distance from Moor Lynch to Pilsden is 118231,8 feet; and this is the side from which the series about to be carried on, for the survey of the north of Devonshire, is to originate.

In the triangle formed by the stations on Mendip Hills, Bradley Knoll, and Westbury Down, the distance between the first and last is 92954,0 feet; but, computing with the mean distance from Mendip to Bradley Knoll, (61962,3 feet,) as found from both bases, the distance from Mendip to Westbury Down proves to be 92955,9 feet; which distance is used in the remaining principal triangles in this quarter.

XXV.	Farley Down - -	77 21 53,75	−0,44			77 21 52,75	
	Westbury Down -	63 42 51,25	−0,34			63 42 49,75	
	Mendip Hills -	38 55 17,5	−0,30			38 55 17,5	
		180 0 2,5		1,10	+1,40		
	Mendip from { Farley Down - - -						85412,2
	Mendip from { Westbury Down - -						92955,9

No. of triangles.	Names of stations.	Observed angles	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XXVI.	Mendip - -	60 36 15,5	—0,40			60 36 15	
	Dundry - -	69 52 22	—0,44			69 52 22	
	Farley Down -	49 31 23,5	—0,37			49 31 23	
		180 0 1		1,21	—0,21		
		Dundry from { Farley Down - - -					79255,3
		Mendip - - -					69196
XXVII.	Mendip - -	41 3 58,5	—0,25			41 3 58,25	
	Dundry - - -	83 34 18	—0,40			83 34 17,5	
	Lansdown - -	. . .				55 21 44,25	
		Lansdown from { Mendip - - -					83573,2
		Dundry - - -					55249,2
XXVIII.	Dundry - -	13 41 56,25	—0,09			13 41 56	
	Farley Down -	27 5 27,5	—0,11			27 5 27,25	
	Lansdown - -	. . .				139 12 36,75	
		Lansdown from { Farley Down - -					28730,4
		Dundry - - -					55248,7

Wherefore, the mean distance from Dundry to Lansdown is 52248,9 feet.

ART. XIII. *Calculation of the sides of certain principal Triangles, carried on from the side Bagshot Heath and Highclere, towards the north.* Plate XXXI.

Distance from Bagshot Heath to Highclere, 142952,6 feet. Phil. Trans. 1795. p. 496.

XXIX.	Bagshot Heath -	55 32 26	—0,89			55 32 25,25	
	Highclere -	46 10 18,25	—0,83			46 10 17,75	
	Nuffield - -	78 17 18,25	—1,20			78 17 17	
		180 0 2,5		2,94	—0,43		
		Nuffield from { Bagshot Heath - -					105321,2
		Highclere - -					120374

No. of triangles.	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
xxx.	White Horse Hill	63 7 53,25	−0,94			63 7 53,5	
	Highclere - -	63 18 16,75	−0,94			63 18 17	
	Nuffield - -	53 33 49,5	−0,86			63 33 49,5	
		179 59 59,5		2,74	−3,24		
		White Horse Hill from { Nuffield - -					120557,7
		White Horse Hill from { Highclere - -					108563,1

Distance from Beacon Hill to Highclere, 98694,4 feet. Phil. Trans. 1795. p. 497.

xxxi.	Beacon Hill - -	17 42 38,5	−0,12			17 42 38,25	
	Highclere - -	56 0 29,75	+0,08			56 0 29,25	
	Inkpin Hill - -	106 16 53,25	−0,47			106 16 52,5	
		180 0 1,5		0,50	+1,0		
		Inkpin Hill from { Highclere - -					31278,8
		Inkpin Hill from { Beacon Hill - -					85247,9
xxxii.	Highclere - -	34 27 50,75	+0,38			34 27 50,75	
	Inkpin Hill -	133 27 57,5	−0,91			133 27 58	
	White Horse Hill	12 4 11,5	+0,04			12 4 11,25	
		179 59 59,75		0,49	−1,24		
		White Horse Hill from { Highclere - -					108565,5
		White Horse Hill from { Inkpin - - -					84647,1

In the following computations, I shall use 120557,7 feet for the distance between White Horse Hill and Nuffield: this is derived from the base on Hounslow Heath. By the last triangle, White Horse Hill, from Highclere, is distant 108565,5 feet; which is computed from the base on Salisbury Plain. The distance between those stations, found by the second of the above triangles, is 108563,1 feet. Therefore, whether the distance between White Horse Hill and Nuffield be founded on the base measured on Salisbury Plain, or Hounslow Heath, nearly the same conclusion is derived: the difference will

not amount to four feet; a small quantity in a side of three-and-twenty miles. I shall, however, use 120557,7, because I think it the most accurate determination.

No. of triangles.	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XXXIII.	White Horse Hill	38 48 13,25	−0,67			38 48 12,5	
	Nuffield - -	86 4 16,25	−1,21			86 4 15	
	Brill - -	55 7 33,5	−0,71			55 7 32,5	
		180 0 3		2,6	+0,4		
	Brill from { White Horse Hill - -						146603,2
	Brill from { Nuffield - - -						92085,5
XXXIV.	Brill - -	50 14 44,5	−1,18			50 14 45	
	White Horse Hill	64 45 43,75	−1,34			64 45 42,5	
	Stow on the Wold	64 59 32	−1,35			64 59 45	
		180 0 0,25		3,88	−3,63		
	Stow from { White Horse Hill - -						124365,6
	Stow from { Brill - - - -						140326,3
XXXV.	Brill - -	32 34 43	−0,61			32 34 42,25	
	Stow - -	60 56 6,25	−0,64			60 56 5,5	
	Epwell - -	86 29 13,5	−1,11			86 29 12,25	
		180 0 2,75		2,37	+0,38		
	Epwell from { Stow - - - -						78938,2
	Epwell from { Brill - - -						128140
XXXVI.	Epwell - -	38 10 44	−0,25			38 10 42,75	
	Stow - -	72 38 49,5	−0,34			72 38 47,5	
	Broadway Beacon	69 10 31,75	−0,32			69 10 29,75	
		180 0 5,25		0,92	+4,33		
	Broadway Beacon from { Stow - - - -						52203,2
	Broadway Beacon from { Epwell - - -						80611,4

No. of triangles.	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XXXVII.	Broadway Beacon	56 32 45	—0,34			56 32 44,75	
	Epwell -	95 34 25,25	—1,02			95 34 24,75	
	Corley - -	27 32 49,75	—0,61			27 32 50,5	
		180 0 0		1,58	—1,58		
		Corley from Broadway Beacon - -					171568
XXXVIII.	Brill - -	34 23 58,5	—0,65			34 23 57,5	
	Epwell -	85 0 18,5	—1,10			85 0 17,5	
	Arbury Hill -	60 35 45,5	—0,70			60 35 57,5	
		180 0 2,5		2,46	—0,04		
		Arbury Hill from { Epwell - -					83098,4
		Brill - -					146530
XXXIX.	Arbury Hill -	89 57 4,5	+3,14			89 57 5,5	
	Epwell -	54 45 18,75	—0,57			54 45 18,25	
	Corley -	35 17 36,75	—0,57			35 17 36,25	
		180 0 0		2,29	—2,29		
		Corley from { Arbury Hill -					117463
		Epwell - -					143827,8

By the triangle Broadway Beacon, Epwell, Corley, (see the above) the distance from Corley to Broadway Beacon is the only distance computed; and this has been obtained through the means of two observed angles only. When the observations were made at Broadway Beacon, it was not imagined Corley could be seen; and the contrary was not known till the party arrived at the latter place. In so large a triangle, it would certainly be right to observe all the angles: but I have given the angles as they now stand, because the distance from Epwell to Corley comes out 143831 feet, which determination differs only three feet from the same distance found by the last triangle.

XL.	Bow Brickhill -	68 22 56,75	—1,21			68 22 59	
	Arbury Hill -	43 16 55,5	—0,99			43 16 54,5	
	Brill - -	68 20 7,75	—1,22			68 20 6,5	
		180 0 0		3,43	—3,43		
		Bow Brickhill from { Arbury Hill - -					146481
		Brill - -					108058,9

It will now be expedient to compute the distance from Bow Brickhill to Brill, by means of another set of triangles. And it was for the express purpose of verifying this distance found by the last triangle, that Scutchamfly Barrow, in Berkshire, and the station above Wendover, were chosen. The base on which these triangles are to rest, is the distance between Nuffield and White Horse Hill, *viz.* 120557,7 feet.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XLI.	Nuffield -	62 32 5,25	—0,53			62 32 6	
	White Horse Hill	35 34 23,25	—0,47			35 34 24	
	Shotover Hill -	81 53 29,75	—0,74			81 53 30	
		179 59 58,25		1,75	—3,5		
	Shotover Hill from	{ White Horse Hill -					108050,2
		{ Nuffield - -					70842,1
XLII.	Shotover Hill -	26 8 8	—0,12			26 8 8	
	White Horse Hill	42 4 2	—0,04			42 4 2	
	Scutchamfly Barrow	111 47 50	—0,70			111 47 50	
		180 0 0		0,86	—0,86		
	Scutchamfly Barrow from	{ White Horse Hill -					51261,9
		{ Shotover Hill - -					77968,3
XLIII.	Shotover Hill -	117 30 56	—1,41			117 30 55,25	
	Scutchamfly Barrow	34 26 52	—0,01			34 26 52	
	Wendover -	28 2 12,75	—0,09			28 2 12,75	
		180 0 0,75		1,52	—0,77		
	Wendover from	{ Scutchamfly Barrow -					147113,3
		{ Shotover - -					93828,6

No. of triangles	Names of Stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
							Feet.
XLIV.	Wendover	23 23 57,5	0,11	"	"	23 23 57,25	
	Shotover Hill	48 30 39,75	0,04			48 30 40,5	
	Brill	. . .				108 5 22,25	
				1,21			
	Brill from { Wendover						73940,3
	Brill from { Shotover Hill						39200,2
XLV.	Wendover	80 11 9,25	—0,67			80 11 8,5	
	Brill	57 25 1,5	—0,47			57 25 0,75	
	Bow Brickhill	42 23 50,75	—0,44			42 23 50,75	
		180 0 1,51		1,58	—0,07		
	Bow Brickhill from { Wendover						92400,7
	Bow Brickhill from { Brill						108055

According to the first determination, the distance from Bow Brickhill to Brill is 108058,9 feet, and by the last, 108855 feet. There is, therefore, a difference of 4 feet nearly; a quantity which must be deemed inconsiderable; hence, 108056,9 feet may be taken for the true distance.

XLVI.	Kinsworth	62 55 38,75				62 55 38,5	
	Bow Brickhill	88 42 0				88 41 59,25	
	Brill	. . .				28 22 22,25	
	Kinsworth from { Brill						121322,5
	Kinsworth from { Bow Brickhill						57608
XLVII.	Wendover	33 26 48				33 26 49	
	Quainton	94 58 37				94 58 38	
	Brill	51 34 33				51 34 33	
		179 59 58		0,55	—2,55		
	Quainton from { Brill						40908
	Quainton from { Wendover						58146,4

No. of triangles	Names of Stations.	Angles observed.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
XLVIII.	Bow Brickhill -	38 51 40,75				38 51 40,75	
	Wendover - -	46 44 29,5				46 44 29,25	
	Quainton -	94 23 50,25				94 23 50	
		180 0 1,25		0,83	+0,42		
		Quainton from { Wendover - -					58146,9
		Quainton from { Bow Brickhill -					67491,3

In the above triangle, I have computed the distances of Wendover and Bow Brickhill from Quainton with 92400,7 feet, the side Wendover and Bow Brickhill, as determined in a former triangle.

XLIX.	Bow Brickhill -	85 9 52,75				85 9 52	
	Kinsworth -	52 17 56,75				52 17 56	
	Quainton - -	. . .				42 32 12	
		Quainton from { Kinsworth - -					84997
		Quainton from { Bow Brickhill -					67490,3

Therefore, 67490 may be considered as nearly the true distance, in feet, between Quainton and Bow Brickhill.

L.	Bow Brickhill -	42 10 36,75				42 10 36,5	
	Kinsworth -	82 50 30,5				82 50 30	
	Lillyhoe - -	54 38 53				54 38 53,5	
		180 0 0,25		1,26	—1,50		
		Lillyhoe from { Kinsworth -					47278,7
		Lillyhoe from { Bow Brickhill -					69867

As the stations Lidlington, Trusler Hill, together with Crouch Hill, Cumner Hill, and Whiteham Hill, have been used for purposes of greater importance than secondary ones have been generally applied to, I shall insert the triangles formed by their intersections in this article.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
LI.	Kinsworth -	31 4 5				31 4 4	
	Bow Brickhill -	80 39 37,25				80 39 34,75	
	Lidlington -	68 16 22,25				68 16 21,25	
		180 0 4,5		0,42	+4,92		
	Lidlington from { Bow Brickhill -						32035,6
	Kinsworth -						61255,3
LII.	Lillyhoe - -	78 58 26				78 58 26	
	Kinsworth -	51 46 22				51 46 22	
	Lidlington -	. . .				49 15 12	
	Lillyhoe from { Kinsworth - -						47280
	Lidlington -						49025

The distance from Lillyhoe to Kinsworth, as found in a former triangle, is 47278,1 feet, and by the last 47280 feet; therefore, 47279,3 may be taken for the true distance in feet.

LIII.	Bow Brickhill -	38 28 56				38 28 56	
	Lillyhoe - -	23 59 31				23 59 31	
	Lidlington -	. . .				117 31 33	
	Lillyhoe from { Lidlington - -						49027,3
	Bow Brickhill -						69869

And this triangle, with that preceding it, gives the mean distance between Lillyhoe and Lidlington = 49026,1 feet; and, with the triangle Lillyhoe, Kinsworth, and Bow Brickhill, it assigns 69868 feet for the mean distance between Lillyhoe and Bow Brickhill.

LIV.	Lillyhoe - -	5 52 11,5				5 52 11,5	
	Bow Brickhill -	14 54 42,75				14 54 42,75	
	Trusler Hill -	. . .				159 13 5,75	
	Trusler Hill from { Bow Brickhill -						20138,7
	Lillyhoe - -						50673,6

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
LIV.	Crouch Hill -	145 23 26,25				145 23 26	
	Epwell - -	27 3 10				27 3 10	
	Brill - -	. . .				7 33 24	
	Crouch Hill from { Brill - -						102608
	Crouch Hill from { Epwell - -						29668,8

Distance from White Horse Hill to Shotover Hill 108050,2 feet.

LV.	Shotover Hill -	48 5 32,75				48 5 32,25	
	White Horse -	16 59 53,75				16 59 53,25	
	Whiteham Hill -	114 54 34,75				114 54 34,5	
		180 0 1,25					
	Whiteham Hill from { White Horse Hill -						88662,2
	Whiteham Hill from { Shotover Hill -						34827,4
LVI.	Whiteham Hill -	55 52 35				55 52 36	
	Shotover Hill -	24 37 36				24 37 37	
	Cumner Hill -	99 29 48,5				99 29 47	
		179 59 59,5					
	Cumner Hill from { Shotover Hill - -						29231,5
	Cumner Hill from { Whiteham Hill -						14714,3

And, because the Observatory of his Grace the Duke of MARLBOROUGH, at Blenheim, together with that at Oxford, have been observed with the same care and attention as the principal stations, and also because precise determinations of the situations are of great importance, I shall here insert the triangles formed by their intersections.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
LVII.	Shotover Hill - -	23 11 5				23 11 5	
	Cumner Hill - -	29 23 33				29 23 33	
	The Atlas on the top of the Observatory at Oxford	. . .				127 25 22	
	Oxford Observatory from { Cumner Hill - -						14492
	Oxford Observatory from { Shotover Hill - -						18065,1
LVIII.	Whiteham Hill -	131 25 36,5				131 25 35,5	
	White Horse Hill -	10 30 43,5				10 30 43,75	
	Blenheim Observatory	. . .				38 3 40,75	
	Blenheim Observatory from { White Horse Hill -						107831,9
	Blenheim Observatory from { Whiteham Hill - -						26237,6

ART. XIV. *Triangles for connecting the Series carried on from Scutchamfly Barrow and White Horse Hill, in Berkshire, into Buckinghamshire and Bedfordshire, with the Series carried on for the Survey of Essex.*

The angle at St. Ann's Hill, between the station on Hanger Hill Tower and Hampton Poor House, inferred from General Roy's Account, is 25° 38′ 58″,5. In 1793, the angle between the staff on Pen Church Tower and Hampton Poor House was taken, and found = 95° 57′ 34″,5; therefore, the angle between Pen Tower and Hanger Hill is 70° 23′ 36″.

The distance from St. Ann's Hill to Pen is determined by

the following triangle, in which the distance between St. Ann's Hill and Bagshot Heath, *viz.* 46955,8 feet, (see Phil. Trans. for 1795, p. 496,) is used for the base.

No. of triangles	Names of stations.	Observed angles.	Diff.	Spherical excess.	Error.	Angles corrected for calculation.	Distances.
		° ′ ″	″	″	″	° ′ ″	Feet.
LIX.	St. Ann's Hill	80 43 48				80 43 48	
	Bagshot - -	70 30 37				70 30 37	
	Pen Tower -	. . .				28 45 35	
	Pen Tower from { St. Ann's Hill - -						92000,5
	Pen Tower from { Bagshot Heath - -						96318

The distance from St. Ann's Hill to Hanger Hill Tower is 68895,8 feet: this is derived from the *mean* length of the base on Hounslow Heath. This side, together with St. Ann's Hill and Pen, using the included angle at St. Ann's Hill, as found above, give 94640,5 feet, for the distance between Pen and Hanger Hill Towers.

The angle at St. Ann's Hill, between Bagshot Heath and Hanger Hill Tower, is 151° 7′ 24″,25: this, with the sides Bagshot Heath and St. Ann's, St. Ann's and Hanger Hill, give 17° 13′ 48″, for the angle at Bagshot Heath, between Hanger Hill Tower and St. Ann's Hill: hence we have the following triangle.

Bagshot Heath	- -	16° 45′	43″
Hanger Hill	- -	103 18	23
Stanmore	- -	59 55	54

Which triangle gives 37431 feet, for the distance between Stanmore and Hanger Hill Tower.

The angle at the station on Bow Brickhill, (see the preceding article,) between Wendover and Kinsworth, is 46° 18′ 8″,5; and the distances from it to these stations are 92402,2 feet, and 57668 feet respectively: these give the following triangle.

Bow Brickhill	-	46° 18′	8″,5
Wendover -	-	38 25	21,25
Kinsworth -	-	95 16	30,25

From which the distance between Wendover and Kinsworth is found = 67090,7 feet. The observed angle at Wendover, between Bow Brickhill and Stanmore, is 102° 22′ 29″; from which, subtracting 38° 25′ 21″,25, the angle between Bow Brickhill and Kinsworth, we get 63° 57′ 7″,75, for the angle between Kinsworth and Stanmore. Again, the observed angle at Kinsworth, between Bow Brickhill and Stanmore, is 173° 37′ 44″; from which, subtracting the angle between Bow Brickhill and Wendover, we get 78° 21′ 13″,75, for the angle between Stanmore and Wendover. If these *computed* angles are actually such as might be observed, were Kinsworth and Wendover visible from each other, the angle at Stanmore between those stations ought to be 37° 41′ 39″, nearly: but the observed angle was 37° 41′ 41″,75; which is so nearly the computed one, as to leave little doubt of the accuracy of those *data* from which the angles are derived. The distance from Wendover to Kinsworth is 67090,7 feet.

Wendover -	63	57	7,75	
Kinsworth -	78	21	13,75	which, corrected for calculation, becomes,
Stanmore - -	37	41	41,75	
	180	0	3,25	

	°	′	″
Wendover -	63	57	7
Kinsworth -	78	21	12
Stanmore -	37	41	41

which triangle gives

the distance of Stanmore from { Wendover = 107464,1 / Kinsworth = 98577,5 } feet.

In consequence of Bushy Heath intercepting the view towards the east from Stanmore, it became necessary to choose a station on the former. To determine the distance, the angles at the two stations were taken very accurately; they were as follows,

Stanmore -	42	11	21,5
Bushy Heath	135	35	40,5
Kinsworth,	.	.	.

which gives 5483,3 feet for the required distance.

To determine the distance of the station on Pen Church Tower, we have two angles in the following triangle, *viz.*

Wendover -	38	13	18
Stanmore -	23	44	48
Pen Tower -	118	1	54

which, corrected for calculation, becomes,

Wendover -	38	13	18,25
Stanmore -	23	44	48,25
Pen Tower -	118	1	54,5

which triangle gives

the distance of Pen from { Wendover = 49027 / Stanmore = 75325,4 } feet.

With this distance of Stanmore from Pen, found from the last triangle, and also that between Stanmore and Hanger Hill, derived from the triangle, Bagshot Heath, Hanger Hill, and Stanmore, together with the included angle at Stanmore, *viz.* 109′ 28′ 22″,5, we get the distance of Pen to Hanger Hill Tower = 94631,8 feet. The same distance has been found before, in a shorter and more direct way, being 94640,5 feet: the difference is only 8,7 feet; a sufficient proof that the distances given for the survey of this intricate and woody country, are

sufficiently correct. It will be more convenient to show how these triangles are connected with those to the eastward, when I arrive at that part of the work which treats of the survey of Essex, than at present. I shall, therefore, proceed to the following article, after observing, that by the help of Harrow Spire, (the situation of which has been determined by General Roy,) and by observations hereafter to be made with the small instrument on Pen Tower, less difficulty will occur in the interior survey than was at first expected.

ART. XV. *Triangles formed by the intersections of Churches, Windmills, and other Objects.*

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	
	° ′ ″		Feet.
Little Haldon - -	23 54 50	Great Haldon -	18974
Ball's Obelisk - - -	132 41 8		19366
Great Haldon, secondary station			
Great Haldon from Ball's Obelisk 19366 feet.			
Great Haldon - - -	68 0 35	Topsham Steeple -	28316
Ball's Obelisk - -	71 32 30		27679
Topsham Steeple			
Little Haldon from Furland 72776 feet.			
Little Haldon - -	18 2 2	Hope's Nose -	37656
Furland - - -	18 42 53		39028
Hope's Nose, secondary station			
Bodmin from Trevose 81967,6 feet.			
Bodmin - -	15 48 43	St. Minvern Steeple	45936
Trevose - - -	21 28 36		36866
St. Minvern Steeple			
Bodmin - -	12 5 33	St. Minvern Windmill	34852
Trevose - - -	8 46 51		48478
St. Minvern Windmill			

Trevose from Cadon Barrow 85624.8 feet.

Triangles.	Angles observed.	Distances of the stations from the intersected objects.	
	° ′ ″		
Trevose	55 38 59	St. Isey Steeple	29256
Cadon Barrow	19 15 48		73216
St. Isey Steeple			
Trevose	58 41 39	St. Merian Steeple	10894
Cadon Barrow	6 38 22		80504
St. Merian Steeple			

Black Down from St. Stephen's 62506,7 feet.

Black Down	4 46 37	Werrington Steeple	61289
St. Stephen's Down	74 20 14		5301
Werrington Steeple			
Black Down	15 18 49	Boyton Steeple	69897
St. Stephen's	104 53 9		19101
Boyton Steeple			
Black Down	1 8 22	St. Stephen's Steeple	60448
St. Stephen's	30 7 22		2395
St. Stephen's Steeple			
Black Down	5 31 36	North Petherwin Steeple	77698
St. Stephen's	153 13 23		16610
North Petherwin Steeple			

Carraton from St. Stephen's 52994 feet.

Carraton	50 40 15	Stokeclimsland Steeple	32886
St. Stephen's	38 21 4		40997
Stokeclimsland Steeple			
Carraton	6 11 7	Launceston Steeple	49613
St. Stephen's	55 32 16		6483
Launceston Steeple			
Carraton	5 58 26	Launceston Chapel	49404
St. Stephen's	53 7 35		6427
Launceston Chapel			

Long Knoll from Westbury 58118,2 feet.

Long Knoll	45 5 0	Frome Steeple	33765
Westbury	34 53 50		41793
Frome Steeple			

Lansdown from Farley Down 28730,4 feet.

Triangles.	Angles observed.	Distances of the stations from the intersected objects.	Feet.
	° ′ ″		
Lansdown - -	56 43 16	Cold Aston -	13563
Farley Down - - -	28 2 35		24120
Cold Aston			

Moor Lynch from Dundon 32688,8 feet.

Moor Lynch - -	15 54 56	Walton Windmill -	20406
Dundon - - -	23 11 6		14213
Walton Windmill			
Moor Lynch - -	123 0 11	Westonzoyland Steeple	17688
Dundon - - -	19 18 55		44848
Westonzoyland Steeple			
Moor Lynch - - -	91 5 56	Middlezoy Steeple -	15691
Dundon - - -	25 20 0		30530
Middlezoy Steeple			
Moor Lynch - - -	153 58 50	Chedzoy Steeple -	19454
Dundon - - -	9 39 13		29556
Chedzoy Steeple			
Moor Lynch - -	29 20 18	Highham Windmill	24457
Dundon - - -	46 30 22		10518
Highham Windmill			
Moor Lynch - -	36 25 56	Highham Steeple -	21567
Dundon - - -	39 51 57		19982
Highham Steeple			
Moor Lynch - -	147 57 0	Bridgewater Spire -	33656
Dundon - - -	16 15 14		63768
Bridgewater Spire			
Moor Lynch - -	69 52 39	Burton Pynsent Obelisk	40063
Dundon - - -	63 18 59		42101
Burton Pynsent Obelisk			
Moor Lynch - -	12 12 41	Somerton Steeple -	40792
Dundon - - -	129 45 57		11221
Somerton Steeple			

Dundry from Lansdown 55248,9 feet.

Triangles.	Angles observed.	Distances of the stations from the intersected objects.	Feet.
Dundry	° ′ ″ 22 7 16	Puckle Church Steeple	57757
Lansdown	85 25 0		21819
Puckle Church Steeple			
Dundry	30 37 18	Westleigh Steeple	61842
Lansdown	86 18 39		31566
Westleigh Steeple			
Dundry	51 19 11	Bristol Cathedral	21920
Lansdown	22 23 3		44935
Bristol Cathedral			
Dundry	44 18 9	Redcliff Steeple	22096
Lansdown	21 22 24		42346
Redcliff Steeple			
Dundry	78 18 19	Long Aston Steeple	13883
Lansdown	14 32 8		54168
Long Aston Steeple			
Dundry	67 33 51	Clifden Windmill	12860
Lansdown	13 17 8		51725
Clifden Windmill			
Dundry	75 37 25	Blaze Castle	38391
Lansdown	39 7 35		58932
Blaze Castle			
Dundry	89 10 18	Penpole Park Gazebo	35391
Lansdown	32 52 56		65180
Penpole Park Gazebo			
Dundry	32 16 31	St. George's Steeple	32391
Lansdown	31 49 52		32795
St. George's Steeple			
Dundry	44 54 50	Duke of Beaufort's House	41168
Lansdown	48 5 1		39064
Duke of Beaufort's House, Stoke			
Dundry	57 15 32	Harfield Steeple	35182
Lansdown	39 14 57		40773
Harfield Steeple			

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
	° ′ ″		
Dundry - - -	13 58 8	} Durham Steeple - {	66541
Lansdown - - -	120 8 3		18573
Durham Steeple			
Dundry - - -	63 45 11	} Knowle Steeple - {	56512
Lansdown - - -	59 9 55		59030
Knowle Steeple			
Dundry - - -	29 42 10	} Mangotsfield Steeple - {	47845
Lansdown - - -	59 59 41		27376
Mangotsfield Steeple			
Dundry - - -	46 12 31	} Winterbourn Steeple - {	55045
Lansdown - -	66 38 49		43280
Winterbourn Steeple			
Mendip from Dundry 69196 feet.			
Dundry - - -	15 0 54	} Leigh Steeple on Mendip {	76847
Mendip - - -	104 10 15		20533
Leigh Steeple on Mendip			
Dundry - - -	90 22 22	} Dundry Steeple - {	1417
Mendip - - -	1 10 22		69221
Dundry Steeple			
Mendip from Long Knoll 61962,3 feet,			
Long Knoll - - -	7 20 24	} Doulting Spire - {	49286
Mendip - - -	25 42 22		14517
Doulting Spire			
Farley Down from Westbury 59849,5 feet,			
Westbury - - -	81 25 20	} Devizes Steeple - {	51197
Farley Down - - -	44 6 53		72726
Devizes Steeple			
Whitehorse from Scutchamfly 51261,9 feet.			
Whitehorse - - -	32 55 51	} Abingdon Spire - {	72898
Scutchamfly - - -	104 3 27		40852
Abingdon Spire			

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
Whitehorse Scutchamfly *Wallingford Steeple*	° ′ ″ 10 39 30 158 52 26	Wallingford Steeple	101693 52185
Whitehorse Scutchamfly *Great Coxwell Windmill*	121 19 20 21 7 0	Great Coxwell Windmill	30295 71834
Whitehorse Scutchamfly *Highworth Steeple*	153 24 7 11 21 56	Highworth Steeple	38449 87355
Whitehorse Scutchamfly *Drayton Steeple*	28 6 9 99 45 35	Drayton Steeple	63991 30586
Whitehorse Scutchamfly *Radley Steeple*	34 8 57 109 33 56	Radley Steeple	81618 48624
Whitehorse Scutchamfly *Buckland Steeple*	75 25 57 44 15 50	Buckland Steeple	41189 57115
Whitehorse Scutchamfly *Witney Steeple*	81 19 12 62 34 49	Witney Steeple	57229 86007
Whitehorse Scutchamfly *Bampton Steeple*	90 57 40 48 27 50	Bampton Steeple	58992 78799

Whiteham from Brill 62066,1 feet.

Whiteham Brill *Islip Steeple*	19 47 5 14 55 46	Islip Steeple	28983 38073
Whiteham Brill *Woodstock Steeple*	78 47 7 25 3 58	Woodstock Steeple	27956 64725
Whiteham Brill *Kidlington Spire*	38 39 25 18 59 22	Kidlington Spire	24677 47373

Whitehorse from Brill 146603.2 feet,

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
Whitehorse Brill *Witchwood Forest Beacon*	° ′ ″ 46 10 15 40 32 9	Witchwood Forest Beacon	95439 105936

Broadway from Epwell 80611.4 feet.

Broadway Epwell *Warwick Steeple*	46 51 21 85 48 34	Warwick Steeple	109337 79992
Broadway Epwell *St. Martin's Spire, Coventry*	49 43 19 100 10 39	St. Martin's, Coventry	158205 122627
Broadway Epwell *Soleyhull Spire*	71 52 32 74 53 55	Soleyhull Spire	142027 139806

Corley from Arbury Hill 117463 feet.

Corley Arbury *Dun Church Windmill*	10 17 47 18 1 45	Dun Church Windmill	70621 44249
Corley Arbury *Gazebo on Bardon Hill, Leicestershire*	107 11 9 34 20 2	Gazebo on Bardon Hill	106471 180344
Corley Arbury *Markfield Windmill*	100 41 54 36 37 26	Markfield Windmill	103373 170270
Corley Arbury *Newnham Windmill*	2 45 41 101 33 35	Newnham Windmill	118771 5845

Corley from Broadway 171570 feet.

Broadway Corley *Building on Breadon Hill*	96 31 27 14 33 9	Building on Breadon Hill	46201 182682

Epwell from Crouch Hill 29668,8 feet,

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
Epwell Crouch Hill *Deddington Steeple*	° ′ ″ 24 43 28 124 8 31	Deddington Steeple	47493 24000
Epwell Crouch Hill *Bloxham Spire*	22 2 57 89 27 20	Bloxham Spire	31887 11971
Epwell Crouch Hill *Aynoe Steeple*	12 41 39 155 28 33	Aynoe Steeple	60070 31802
Epwell Crouch Hill *Adderbury Spire*	12 45 23 143 29 30	Adderbury Spire	43823 16265
Epwell Crouch Hill *Farthingo Steeple*	9 33 29 162 29 20	Farthingo Steeple	64520 35605

Epwell from Arbury Hill 83098,4 feet.

Epwell Arbury Hill *Round House, Edge Hills*	27 30 1 8 9 42	Round House, Edge Hills	20235 65816
Epwell Arbury Hill *St. Martin's, Coventry*	50 9 8 87 15 6	St. Martin's, Coventry	122636 94262
Epwell Arbury Hill *Round House Windmill, Edge Hills*	28 31 46 7 34 6	Round House Windmill	18576 67364

Brill from Quainton 40908,6 feet.

Brill Quainton *Wingrove Steeple*	19 36 52 140 7 47	Wingrove Steeple	75747 39665
Brill Quainton *Hardwick Steeple*	16 25 48 128 12 5	Hardwick Steeple	55539 19989

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
Brill Quainton *Luggersal Steeple*	° ′ ″ 16 42 12 4 24 16	Luggersal Steeple	8710 32664
Brill Quainton *Granborough Steeple*	8 30 43 144 20 22	Granborough Steeple	52266 13270
Brill Quainton *Bicester Steeple*	105 7 30 32 10 53	Bicester Steeple	32132 58210
Brill Quainton *Centre of the Great House at Wooton*	17 37 12 9 28 57	House at Wooton	14793 27181

Stow from Broadway 52203,2 feet.

Stow Broadway *Sarsden Chapel*	123 23 50 19 25 13	Sarsden Chapel	28720 72115
Stow Broadway *Walford Spire*	56 10 42 49 34 47	Walford Spire	41295 45063
Stow Broadway *Bourton Chapel*	14 3 44 21 32 40	Bourton Chapel	32926 21786

Stow from Epwell 78938,2 feet.

Stow Epwell *Stow on the Wold Steeple*	60 30 20 6 37 9	Stow on the Wold	9876 74573

Wendover from Brill 92400,7 feet.

Brill Wendover *Pitchcot Windmill*	43 30 12 46 37 4	Pitchcot Windmill	53739 50901

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
	° ′ ″		
Brill	24 15 12	Ivinghoe Spire	98663
Wendover	111 33 40		43577
Ivinghoe Spire			
Brill	66 36 4	Padbury Steeple	72943
Wendover	46 32 33		92401
Padbury Steeple (doubtful)			
Brill	46 40 52	Quainton Steeple	39009
Wendover	31 1 48		55056
Quainton Steeple			

Wendover from Quainton 72889,4 feet.

Wendover	34 46 37	Wing Steeple	52487
Quainton	45 9 20		42230
Wing Steeple			
Wendover	44 58 11	Crindon Windmill	66472
Quainton	61 9 59		53626
Crindon Windmill			

Quainton from Bow Brickhill 67490,6 feet.

Quainton	75 15 34	Southern Obelisk	58876
Bow Brickhill	47 19 1		77449
Southern Obelisk, Slow Park, Bucks			
Quainton	75 4 46	Northern Obelisk	61881
Bow Brickhill	49 13 49		78942
Northern Obelisk, Slow Park			

Wendover from Kinsworth 84462 feet.

Kinsworth	69 56 52	Leighton Buzzard	35317
Wendover	31 6 26		64215
Leighton Buzzard Spire			

Kinsworth from Quainton 84996,3 feet.

Kinsworth	17 49 12	Aylesbury Steeple	70886
Quainton	51 5 23		27879
Aylesbury Steeple			

Bow Brickhill from Lidlington 32035,6 feet.

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
Bow Brickhill Lidlington *North Crawley Spire*	° ′ ″ 57 43 21 65 40 39	North Crawley Spire	34968 32444
Bow Brickhill Lidlington *Pavenham Spire*	45 8 47 112 13 11	Pavenham Spire	77064 59014
Bow Brickhill Lidlington *St. Paul's Spire, Bedford*	24 15 25 137 19 21	St. Paul's, Bedford	68727 41652
Bow Brickhill Lidlington *Sharnbrook Spire*	48 2 42 111 8 15	Sharnbrook Spire	84080 67038
Bow Brickhill Lidlington *Woburn Market House*	38 42 47 19 39 20	Woburn Market House	12656 23533
Bow Brickhill Lidlington *Ridgemont Station*	5 3 35 10 6 1	Ridgemont Station	21484 10804
Bow Brickhill Lidlington *Wootton Spire*	25 51 29 116 31 15	Wootton Spire	46959 22889
Bow Brickhill Lidlington *Cranfield Spire*	36 40 14 64 51 26	Cranfield Spire	29599 19526

Lillyhoe from Lidlington 49026,1 feet.

Lillyhoe Lidlington *Pollux Hill Spire*	3 1 25 3 2 10	Pollux Hill Spire	24604 24489
Lillyhoe Lidlington *Bow Brickhill Steeple*	23 13 23 119 15 11	Bow Brickhill Steeple	70224 31738
Lillyhoe Lidlington *Colmworth Spire*	49 54 3 100 30 33	Colmworth Spire	97617 75944

Triangles.	Angles observed.	Distances of the stations from the intersected objects.	Feet.
Lillyhoe Lidlington *Silsoe Spire*	° ′ ″ 23 57 30 22 4 36	Silsoe Spire	25599 27658
Lillyhoe Lidlington *Flitton Steeple*	11 46 23 17 18 29	Flitton Steeple	30008 20580
Lillyhoe Lidlington *Shillington Steeple*	57 56 38 19 37 7	Shillington Steeple	16857 42549
Lillyhoe Lidlington *Westoning Steeple*	14 35 24 24 29 56	Westoning Steeple	32242 19586
Lillyhoe Lidlington *Wrest Garden Obelisk*	23 40 47 19 18 12	Wrest Garden Obelisk	23770 28880
Lillyhoe Lidlington *St. Neot's Steeple*	63 39 11 88 31 51	St. Neot's Steeple	105026 94147

Kinsworth from Lidlington 61255,3 feet.

Kinsworth Lidlington *Harlington Steeple*	17 4 20 23 39 1	Harlington Steeple	37666 27565
Kinsworth Lidlington *Maulden Steeple*	17 22 11 87 3 13	Maulden Steeple	63165 18882
Kinsworth Lidlington *Millbrook Steeple*	3 53 24 73 16 9	Millbrook Steeple	60167 42622
Kinsworth Lidlington *Streatly Steeple*	36 15 30 33 41 7	Streatly Steeple	36167 38567
Kinsworth Lidlington *Hanslop Spire*	34 29 11 166 4 4	Hanslop Spire	111928 70552

Kinsworth from Bow Brickhill 57668 feet.

Triangles.	Angles observed.	Distances of the Stations from the intersected Objects.	Feet.
Bow Brickhill Kinsworth *Souldrope Spire*	° ′ ″ 131 31 20 30 17 44	Souldrope Spire	93229 138367
Bow Brickhill Kinsworth *Sauldon Windmill*	91 22 55 28 24 55	Sauldon Windmill	31623 66434
Bow Brickhill Kinsworth *Stewkley Windmill*	70 9 33 33 27 4	Stewkley Windmill	32706 55812
Bow Brickhill Kinsworth *Tharfield Windmill*	61 57 57 93 30 13	Tharfield Windmill	139157 123073
Bow Brickhill Kinsworth *Tottenhoe Station*	4 13 44 14 47 27	Tottenhoe Station	43177 13049
Bow Brickhill Kinsworth *Chalgrave Steeple*	21 55 14 43 21 54	Chalgrave Steeple	43590 23099
Bow Brickhill Kinsworth *Lidlington Windmill*	85 34 3 27 23 29	Lidlington Windmill	28814 62442
Bow Brickhill Kinsworth *Keysoe Spire*	116 46 10 42 6 4	Keysoe Spire	107275 142850

Lillyhoe from Trusler Hill 50673,6 feet.

Lillyhoe Trusler Hill *Knotting Green Elm Tree*	51 56 21 103 29 55	Knotting Green Elm Tree	118536 95981
Lillyhoe Trusler Hill *Sundon Windmill*	36 45 37 27 4 1	Sundon Windmill	25692 33790

Bow Brickhill from Trusler Hill 20138,7 feet.

Triangles.	Angles observed.	Distances of the stations from the intersected objects.	
	° ′ ″		
Bow Brickhill Trusler Hill *Crawley Steeple*	25 13 54 50 16 22	Crawley Steeple	15998 8867
Bow Brickhill Trusler Hill *Moulshoe Steeple*	93 18 15 49 17 46	Moulshoe Steeple	25136 33101
Bow Brickhill Trusler Hill *Woburn Steeple*	13 27 17 19 46 14	Woburn Steeple	12432 8552

Bow Brickhill from Lillyhoe 69867 feet.

Bow Brickhill Lillyhoe *Renhold Steeple*	60 57 17 68 45 59	Renhold Steeple	84608 79373
Bow Brickhill Lillyhoe *Ravensden Steeple*	64 55 32 66 41 24	Ravensden Steeple	85825 84646

Kinsworth from Lillyhoe 47278,7 feet.

Kinsworth Lillyhoe *Flitwick Steeple*	43 44 48 71 53 53	Flitwick Steeple	49849 36264

SECTION SECOND.

Determination of the Latitudes and Longitudes of the Stations on Black Down, in Dorsetshire, Butterton, in Devonshire, and St. Agnes Beacon, in Cornwall.

ART. XVI.—*Calculation of the Distance between Black Down and Dunnose in the Isle of Wight.*

To complete this distance, I shall have recourse to the XXVIth and XXVIIth triangles, published in the Philosophical Transactions of 1795, and LIIId and LIVth of the Trans. for 1797, together with the observations made at Black Down, in the latter year. (See also Pl. XXX. Fig. 1.).

The most eligible method of calculating with these *data*, seems to be that of first finding the *cross-distance* between Black Down and Dean Hill. To do this, we have the angle at Nine Barrow Down, between Black Down and Dean Hill, and the respective distances from the first to the latter stations, together with the newly observed angle between Dunnose and Nine Barrow Down; from which we obtain the angles of a triangle, constituted by Dunnose, Nine Barrow Down, and Black Down.

The distance from Nine Barrow Down to Dean Hill is 166497 feet, and, from the same station to Black Down, the distance is 126782 feet, (see Phil. Trans. for 1795, p. 502, and for 1797, p. 455,) and the angle comprehended by those distances $= 110^\circ\ 30'\ 13'',25$. The difference between the horizontal angle and that formed by the chords is $3'',25$, which, substracted from $110^\circ\ 30'\ 13'',25$, leaves $110^\circ\ 30'\ 10''$: computing with this

angle and the sides spoken of, there results the following triangle, viz.

Nine Barrow Down	-	110°	30′ 10″
Black Down - -		40	6 54,75
Dean Hill - - -		29	22 55,75

This, using the side Nine Barrow and Dean Hill, (166497 feet,) gives 240236,7 feet, for the distance between Black Down and Dean Hill.

The angle at Dean Hill, between Nine Barrow Down and Dunnose, is 64° 50′ 19″, (see Phil. Trans. for 1795. p. 501,) and the angle between Black Down and Nine Barrow, as just found, is 29° 22′ 55″,75, which, increased by the proper correction for the difference between the chord and horizontal angles, becomes 29° 22′ 57″,5. The sum of these angles ,94° 13′ 16″,5, is the horizontal angle between Black Down and Dunnose.

The angle at Black Down, between Dunnose and Nine Barrow Down, deduced from observations made in 1797, is found to be 4° 30′ 25″,75: this, subtracted from the angle between Dean Hill and Dunnose, leaves 35° 36′ 29″, for the angle at Black Down; which, corrected for the purpose of reduction to their respective chord angles, become 94° 13′ 11″,5, and 35° 36′ 25″,75, from whence we get the angle at Dunnose = 50° 10′ 22″,75. We have, therefore, the following triangle, viz.

Dean Hill - -		94°	13′ 11,5″
Black Down - -		35	36 25,75
Dunnose - - -		50	10 22,75

The distance between Dean Hill and Dunnose is 183496,2 feet, (Phil. Trans. for 1795. p. 501,) and that between Black Down and Dean Hill, according to the foregoing computation, is 240236,7 feet: these, applied to the angles of the above triangle,

give 314309,6, and 314305,4 feet, respectively, for the distance between Black Down and Dunnose: wherefore, the mean 314307,5 feet, = 59,528 miles, may be considered as the true distance between those stations.

Direction of the Meridian at Black Down.

On the 18th of April, in the forenoon, the angle between the Pole Star, when at its greatest apparent elongation from the meridian, was observed, and found to be - 104° 19′ 19″,25

And on the 19th, in the afternoon - 98 42 47

Half their sum is the angle between the meridian and Abbotsbury staff - - 101 31 3

On the 20th of April, in the forenoon, the angle between the Pole Star, when at its greatest apparent elongation from the meridian, was observed, and found to be - 104 19 25,25

And on the 19th, in the afternoon - 98 42 35,5

Half their sum is the angle between the meridian and Abbotsbury staff - - 101 31 0,5

Therefore, 101° 31′ 2″ may be taken for the angle between the meridian and Abbotsbury staff.

ART. XVII.—*Latitude and Longitude of Black Down.*

The angle between Dunnose and the Abbotsbury Staff was observed, and found = 164° 26′ 35″25; and the angle between the meridian and the same staff, by double azimuths of the Pole Star, 101° 31′ 2″. Wherefore their sum, subtracted from 360°, leaves 94° 2′ 22″,75, the angle which Dunnose makes with the meridian.

In Fig. 4. Plate XXX. let *Z* be the zenith, B the station on Black Down, and ZBA its meridian; also, let D be Dunnose, and ZD its meridian; likewise, suppose BC to be an arc of a great circle, perpendicular to the meridian at B, and DA another arc of a great circle, perpendicular to the meridian at D, BF and ED being the parallels of latitude at Black Down and Dunnose.

In the spherical triangle BZD, the angles at B and D are given, the first being 94° 2′ 22″,75, and the second 84° 54′ 53″; therefore, in the triangle ABD the angle at B is 85° 57′ 36″,75, and, in the triangle BDC, the angle at D = 84° 54′ 53″: hence, the angles of these triangles, when reduced to those formed by the chords, are as follows:

In the triangle BDC
DDC = 84′ 54′ 52,5″
CDB = 91 2 44,75
CBD = 4 2 22,75

And in the triangle ABD
ABD = 85 57 36,75
BAD = 88 57 16,25
BDA = 5 5 7

Now the distance between Black Down and Dunnose, BD, has been already found to be 314307,5 feet; therefore, using the above angles with that distance, (after the proper corrections are applied for reducing the horizontal angles to those formed by the chords,) we get,

In the triangle BCD { BC = 313128 / CD = 21146,9 } feet.

And in the triangle ABD { AD = 313581,2 / AB = 27864,5 } feet.

Again, in the two small triangles formed by the parallels BF and ED, the perpendiculars BC and DA, and the small arcs CF and AE, we have the angles at C and A given, the

first being 91° 2′ 45″,75, and the last 88° 57′ 15″; which angles, however, are augmented by the addition of the differences between the horizontal angles and those formed by the chords. We have therefore,

In the triangle BCF
BCF = 91° 2′ 45,75″
BFC = 88 25 51,5
FBC = 0 31 22,75

And in the triangle AED
EAD = 88 57 17
AED = 90 31 21,5
ADE = 0 31 21,5

And, using BC and AD, as found above, we get

CF = 2859,1
And EA = 2859,8 } feet.

Therefore FD = DC + CF = 22146,9 + 2859,1 = 25006 feet. And BE = BA = EA = 27864,5 − 2859,8 = 25004,7 feet. The mean, 25005,3 feet, may be considered as very nearly the true distance between the parallels of Black Down and Dunnose. This method is the same as that made use of in the Phil. Trans. for 1795, p. 521, and affords the means of very accurately determining the distance between the parallels of latitude of the two stations, when the angles were observed with precision, and the direction in which the stations lie, is not much removed from east and west.

This small space, 25004,7 feet, corresponds to 4′ 6″,5, in which I use 60851 fathoms for the length of a degree of the meridian in 50° 41′. See Phil. Trans. for 1795, p. 537.

Now the latitude of Dunnose is 50° 37′ 7″,3, and its longitude 1° 11′ 36″; (Phil. Trans. for 1795, p. 536;) therefore, 50° 37′ 7″,3 + 4′ 6″,5 = 50° 41′ 13″,8, is the latitude of Black Down.

This method of finding the latitude seems to be more correct than by spherical computation; yet, by this latter, nearly the

same conclusion is derived; for, the bearing of Black Down west of Dunnose being 84° 54′ 52″,5, we get the distance of that station from the meridian of the latter = 313072 feet, and from the perpendicular, 27861 feet; which, converted into parts of an arch, according to the lengths of their respective degrees, gives 50° 41′ 14″ for the latitude, and 1° 20′ 46″,4 for the longitude west of Dunnose. According to the troublesome yet ingenious method recommended by M. Sejour, in his *Traité Analytique des Mouvemens apparens des Corps Célestes*, the latitude of Black Down comes out 50° 41′ 13″,9, and the longitude 1° 20′ 45″,75. We may, therefore, admitting the supposition of Dunnose being situated in 50° 37′ 7″,3, safely take 50° 41′ 13″,8 for the latitude, and 2° 32′ 22″,4 for the longitude, of Black Down; that of Dunnose being 1° 11′ 36″ west of the meridian of Greenwich.

Art. xviii. *Calculation of the Distance between the Stations on Black Down, in Dorsetshire, and Rippin Tor, in Devonshire.*

For the calculation of this distance, we must have recourse to the xlviiith, xlviiith, xlixth, and lth triangles. (See Philosophical Transactions for 1797, and Plate XXX, Fig. 1 of this Volume.) In the two first, we have the whole angle at Pilsden, between Dumpdon and Black Down = 152° 37′ 27″,25, which, reduced to the angle formed by the chords, becomes 152° 37′ 24″,25. The sides forming this angle, are Dumpdon and Pilsden, Pilsden and Black Down: the distance between the two first stations being 78459,3 feet, and between the two last 79110,7 feet. From these *data*, the distance between Dumpdon and Black Down is found to be 153095,7 feet, the triangle for computation being,

Pilsden	-	-	152° 37′ 24″,25
Black Down	-		13 37 50 ,5
Dumpdon	-	-	13 44 45 ,25

But this side may be also found, by computing with the whole angle at Charton Common, which angle, when reduced to the plane of the chords, becomes 141° 33′ 53″,75. The two sides are 581012,5 feet, and 103345 feet; which *data* give the following triangle:

Charton	-	-	141° 33′ 53″,5
Dumpdon	-		24 48 39 ,25
Black Down	-		13 37 27 ,25;

from whence we find the distance from Dumpdon to Black Down = 153094,6 feet. Wherefore, the mean, 153095,2 feet, may be considered to be very nearly the true distance.

In the LTH triangle, (Cawsand Beacon, Dumpdon, and Little Haldon) the angle at Cawsand Beacon is 43° 14′ 21″,25; and in the LIST, (Rippin Tor, Cawsand Beacon, and Little Haldon) the angle at the same station is 25° 30′ 39″,75; their sum is 68° 45′ 1″, and, adding 1″ for the necessary correction, it becomes 68° 45′ 2″. Computing with this angle, and the including sides, (64020,5 and 18334 feet,) we obtain the following triangle:

Rippin Tor	-	-	90° 34′ 35″
Cawsand Beacon	-		68 45 2
Dumpdon	-	-	20 40 23,

which gives the distance from Dumpdon to Cawsand Beacon = 169014 feet.

In the XLIXth triangle, the observed angle at Dumpdon is found to be 86° 39′ 8″,5, and, by adding to it the horizontal angle at Dumpdon, between Rippin Tor and Little Haldon, and also that between Black Down and Charton Common, we get 125° 54′ 30″,5, for the horizontal angle between Rippin

Tor and Cawsand Beacon. To reduce this angle to that formed by the chords, 6″ must be subtracted; therefore, 125° 54′ 24″,5 is the angle for computation. The sides Dumpdon and Rippin Tor, Dumpdon and Black Down, (169014 and 153095,2 feet,) with this angle, give the following triangle:

Rippin Tor	-	25° 36′ 4″,5
Dumpdon	-	125 54 24,5
Black Down	-	28 29 31,

which gives the distance from Rippin Tor to Black Down = 286973,3 feet.

On referring to the observations made in 1797, on Black Down, it will be seen that the angle between Rippin Tor and the staff erected near Abbotsbury, was 3° 8′ 52″,5, and the angle between Pilsden and the same staff 45° 16′ 13″; their difference, 42° 7′ 20″,5, is the angle between Rippin Tor and Pilsden. Now, if the angles of the triangles, five in number, used in finding the distance between Rippin Tor and Black Down have been observed correctly, and the calculations properly made, the computed angle at Blackdown, between those stations, should be, of course, the same; but the angle formed by the chords of the arcs between Blackdown and Pilsden and Dumpdon, has been found = 13° 37′ 50″,5, (which is very nearly the same as the horizontal one,) and the angle between Dumpdon and Rippin Tor = 28° 29′ 31″, which it is also unnecessary to correct: their sum is 42° 7′ 21″,5, the very angle observed. It is not, perhaps, proper to dismiss this consideration, without observing that this agreement affords a strong proof of the excellence of our instrument, as the triangles, from their magnitude and nature, are not so disposed as to favour the comparison.

ART. XIX. *Latitude and Longitude of Rippin Tor.*

The angle at Blackdown, between the staff at Abbotsbury and the meridian, has been found = 101° 31′ 1″,5, nearly, and that between Rippin Tor and the same staff = 3° 8′ 52″,5; therefore, 98° 22′ 8″ is the angle which Rippin Tor makes with the meridian, and this, taken from 180°, leaves 81° 37′ 52″, the bearing of Rippin Tor SW from Black Down.

This angle, with the distance found above, gives 28585,3 feet, for the distance of Rippin Tor from the meridian of Black Down, and 56086,0 feet, for that from its perpendicular; therefore, the latitude is 50° 33′ 59″,1, and the longitude west from Black Down, 1° 13′ 3″,8; consequently, its longitude west of Greenwich is 3° 45′ 26″2.

Direction of the Meridian at Butterton Hill.

On the 6th of May, in the afternoon, the angle between the Pole Star, when at its greatest apparent elongation from the meridian, and the staff on Hemmerdon Ball was observed, and found to be - - - - -	91° 29′ 13″75
And on the 7th, in the afternoon - -	97 4 14
Half their sum is the angle between the meridian and the staff on Hemmerdon Ball -	94 16 44
Again, on the 7th, in the afternoon, the angle between the Pole Star, when at its greatest apparent elongation from the meridian, and the staff on Hemmerdon Ball was observed, and found to be - - - - -	91 29 12
Half the sum of this, and the angle observed	

in the forenoon of the same day, (97° 4′ 14″)
is - - - - - 94° 16′ 43″

Hence, 94° 16′ 44″ may be considered as the true angle between the meridian and the staff on Hemmerdon Ball.

The angle between the station on Rippin Tor and Hemmerdon Ball, is 121° 17′ 7″,75; therefore, 121° 17′ 7″,75 − 94° 16′ 44″ = 27° 0′ 23″,75, is the bearing of Rippin Tor, north-east of Butterton. This angle, with 62951 feet, gives 28585,2 feet, and 56086,6 feet, for the distance of Rippin Tor from the meridian and perpendicular; which, using 61182 and 60847 fathoms, for the lengths of degrees on the meridian and perpendicular, respectively become 4′ 40″,3, and 9′ 13″. Therefore, in the right angled spherical triangle BPT, (Plate XXX, Fig. 2,) in which B is Butterton, P the pole, T Rippin Tor, and R the point where the parallel to the perpendicular cuts the meridian, we have the co-latitude of T, or Rippin Tor, = 39° 26′ 0″,9, and RT = 4′ 40″,3, We have, consequently, cosine 4′ 40″,3 : radius : : cosine 39° 26′ 0,″9 : cosine 39° 26′ 0,″7, the co-latitude of the point R. So PB = PR + RT = 39° 26′ 0″,7 + 9′ 13″ = 39° 35′ 13″,7; therefore, the latitude of Butterton is 50° 24′ 46″,3, and its longitude west from Greenwich, 3° 52′ 47″,5.

ART. XX. *Calculation of the Distance between Hensbarrow and Butterton.*

The most convenient, as well as the most accurate means of computing this distance, will be by referring to the LVIth, LVIIth, and LXIVth triangles, in the series of 1796, where the sum of the observed angles at Carraton Hill is 136° 52′ 43″. The correction for reducing this angle to that formed by the chords, is 4″; therefore, 136° 52′ 39″ is the proper angle for computation.

The distance from Hensbarrow to Carraton Hill, is 100416 feet, and from Butterton to that station 131576 feet. (See Phil. Trans. for 1797, p. 458, 460.) These *data* give the following triangle, viz.

Carraton Hill	- -	136° 52′ 39″
Hensbarrow	- -	24 35 57,5
Butterton	- -	18 31 23,5, which gives

21602 feet, for the distance between Hensbarrow and Butterton Hill.

The angle between Carraton Hill and Rippin Tor was observed in 1796, and found = 101° 3′ 44″,25. (See Phil. Trans. 1797.) The angle between Hensbarrow and Rippin Tor is 119° 35′ 3″,25; therefore, 18° 31′ 19″ is the angle between Hensbarrow and Carraton. The difference between the horizontal and chord angle is 0″,25 nearly; this, added to 18° 31′ 23″,5, gives 18° 31′ 23″,75, which is nearly the same as the observed angle. This agreement proves, that the angles of the triangles connecting Butterton and Hensbarrow have been observed correctly.

ART. XXI. *Latitude and Longitude of Hensbarrow.*

The angle between Hensbarrow and Hemmerdon, (see Observations made at Butterton,) was 1° 52′ 4″,5; therefore, as the angle between the latter and the meridian = 94° 16′ 44″, we get 92° 24′ 39″,5, for the angle which Hensbarrow makes with the same meridian. The distance from Hensbarrow to Butterton, as found above, is 21602 feet; this, with the angle 92° 24′ 39″,5, gives the distance of Hensbarrow from the meridian = 215871 feet, and from the perpendicular 9089 feet; these, converted into parts of degrees, become 35′ 17″,1, and 1′ 29″,62. There-

fore, the latitude of Hensbarrow is 50° 29′ 3″,3, and its longitude, west of Butterton, 55′ 20″,2; consequently, its longitude, west of Greenwich, is 3° 52′ 47″,5 + 55′ 20″,2 = 4° 48′ 7″,7.

ART XXII. *Direction of the Meridian at St. Agnes Beacon.*

On the 22d of May, in the forenoon, the angle between the Pole Star, when at its greatest elongation from the meridian, and the staff near Peranzabulo, was observed, and found to be - - - - - 38° 26′ 1″,5

And on the 22d, in the afternoon - 44 0 33,25

Half their sum is the angle between the meridian and staff - - - 41 13 17,5

The angle between the staff at Peranzabulo and the station Hensbarrow, was also observed at the same station, and found to be 31° 50′ 55″,5; wherefore, 41° 13′ 17″,5 + 31° 50′ 55″,5 = 73° 4′ 13″, is the angle between Hensbarrow and St. Agnes Beacon.

ART. XXIII. *To find the Latitude and Longitude of St. Agnes Beacon.*

In Plate XXX. Fig. 3. Let A be the station at St. Agnes, P the pole, H Hensbarrow, and B the point where the parallel to the meridian of St. Agnes cuts that meridian, BHP being a right angled spherical triangle on the earth's surface.

PH has been already found = 39° 36′ 56″,7; and, as BH, the distance of Hensbarrow from the meridian, = 92878, and AB, the distance from the perpendicular, = 28271, we get BH = 15′ 10″,9, and AB = 4′ 38″,8; which arcs are found by using 61182 and 60845 fathoms, for the length of their respective

degrees. From these *data*, the latitude of the point B is easily derived; for cosine 15′ 10″,9 : radius :: cosine 39° 36′ 56″,7 : cosine 39° 36′ 54″,2, the co-latitude of B; hence 39° 36′ 54″,2 + 4′ 38″,8 = 39° 41′ 33″,0 the co-latitude of A; hence 50° 18′ 27″ is the latitude of St. Agnes. Its longitude, west from Hensbarrow, is also found by a simple proportion; sine 39° 36′ 54″,2 : radius : : sine 15′ 10″,9 : sine 0° 23′ 48″; therefore, 4° 48′ 7″,7 + 0° 23′ 48″ = 5° 11′ 55″,7, is the longitude of St. Agnes, west of Greenwich.

ART. XXIV.—*Remarks.*

I have shewn, with attention to minuteness, the manner in which the latitudes and longitudes of the stations on which directions of meridians have been observed are determined. It now remains to be considered, how far the uncertain state in which we remain, with respect to the figure of the earth, may affect the accuracy of those conclusions.

If the earth were homogeneous, it would necessarily be an ellipsoid; and, were its diameters known, the longitudes and latitudes of places on its surface might be accurately computed, provided their geodetical situations were correctly ascertained, and the latitude of one station in the series of triangles truly determined.

As there is, however, great reason to suppose that the earth is not any regular geometrical figure, from the impossibility of reconciling the results of the various measurements for ascertaining the lengths of degrees of latitude, some uncertainty must remain with respect to our deductions; but there seems to be reasons for supposing the errors, thence resulting, are confined within moderate limits.

In making computations on a given hypothesis of the earth's figure, the truth of the conclusions, as well as the ease with which they are found, materially depends on the distances of the objects from their respective fixed meridians.

If the difference of longitude approaches nearly to, or exceeds 3°, to compute that longitude, and also the latitude, it is necessary the precise figure should be understood; because the analogy does not hold good, in that case, between the equality of the sums of the angles of spherical and spheroidical triangles on the earth's surface. With regard to latitudes, more particularly when the distances are diminished by means of frequent new directions of meridians, a knowledge of the exact length of a degree of a great circle is not necessary; because the determination of those latitudes, by means of spherical computation, being true as to sense, the cosines of those small arcs will remain the same.

As there cannot be a doubt justly entertained of the latitude of Greenwich being very accurately determined, as particularly set forth by the Astronomer Royal in his reply to M. Cassini, it is reasonable to suppose, that if any errors do exist in the latitudes of those stations, they can only have arisen from the computations being made with erroneous lengths of degrees on the meridian.

In our former Papers on this subject, we have taken it for granted, that the length of a degree of the meridian at the middle point between Greenwich and Paris, (50° 10′,) is 60842 fathoms, (which supposition may be considered just, provided the latitude of Paris, 48° 50′ 14″, be as near the truth as 51° 28′ 40″ is to that of Greenwich,) and afterwards added 9 fathoms,

making it 60851, in order to get the length of the degree in 50° 41′; (see Phil. Trans. 1795, p. 537:) these 9 fathoms, however, were not arbitrarily assumed, but computed. If the latitude of Paris be 48° 50′ 15″, (*Conn. des Tems*, 1797-98, p. 378,) the length of the degree will be about 7 fathoms greater, which will make the degree in 50° 41′, 60849 instead of 60842 fathoms.

The latitude of the station on Beachy Head, 50° 44′ 23″,7, was found by using 60861 fathoms for the length of a degree on the meridian in 51° 6′; but, if it be true that 48° 50′ 15″ is the latitude of Paris, the latitude of Beachy Head will be about one-third of a second greater. This seems to be the limit of the probable error in the computed latitude of this station; since its proximity to the meridian of Greenwich, obviates any doubt of the conclusions being affected by any uncertainty respecting the length of the degree of the great circle perpendicular to the meridian.

The latitude of Dunnose was determined by computing the distance between the parallels of that station and Beachy Head; (see Phil. Trans. for 1795, p. 592;) which method is very exact, and preferable to any other, since the small space between the parallels was determined with great accuracy, leaving not a doubt of a greater error than 3 feet, a quantity corresponding to about $\frac{1}{33}$d part of a second. And, since the same method has been adopted to find the difference of latitude between Black Down and Dunnose, it is highly probable that the latitude of the former station is not removed more than $\frac{3}{10}$ths of a second from the true one, that of Beachy Head being supposed = 50° 44′ 23″,7.

It would have been fortunate, had the difference of latitude between Black Down and Butterton, and Butterton and St. Agnes Beacon, been determined in the same manner, since the latitudes of all these important stations would, in that case, have been found with evident accuracy: but, whoever has leisure and inclination to go through these calculations, will find that, by means of the directions of meridians at Butterton and St. Agnes Beacon, the latitudes of those stations may be found to within half a second. By this I mean, that, allowing the latitude of Black Down to be 50° 41′ 13″,8, the latitude of Butterton, 50° 24′ 46″,8, will not deviate more than half a second from the truth; and the same may be said with respect to the latitude of St. Agnes, that of Butterton being admitted as correct. Supposing, therefore, the latitude of Greenwich to be 51° 28′ 40″, we may rely on the assurance of the latitude of St. Agnes Beacon being determined within 1½″ of the truth.

With respect to the longitudes of these stations, their accuracy entirely depends on the observations made at Dunnose and Beachy Head, for determining the length of a degree of a great circle perpendicular to the meridian. The truth of the deduction drawn from those observations rests on their accuracy; and it can scarcely be deemed presumptuous to assert, that an error of more than 1″ cannot have existed in either of the angles. On this account, therefore, I should suppose, that the difference of longitude between those stations, has been found so nearly as to leave no greater error than 1″. The whole of the operation to which I now allude, was performed with great care; the directions of the meridians having been determined by means of double azimuths of the Pole Star, confirmed by computed azimuths. In returning to the consideration of this sub-

ject, I do not perceive any source of error likely to affect the conclusions, unless it be that to which all astronomical observations, made with instruments adjusted by plumb-lines or levels, are liable. In determining differences of longitude through these means, the direction in which any lateral attraction must act, to produce *a maximum* of error, is at right angles to the meridian. If the attraction be *in the plane of it*, it is obvious the double azimuth, although the telescope of the theodolite does not move in a vertical, will nevertheless give, almost exactly, the true direction of the meridian.

The high lands about St. Catherine's Light-House, in the Isle of Wight, are about six miles from Dunnose, and nearly west of it; but it does not appear that the effect of their lateral attraction can have produced any sensible error; since it may be shewn, that the plumb-line of the sector at Schehallien would have deviated only a small part of a second from the true vertical, had the sector itself been placed at that distance from the hill. Beachy Head is situated at the eastern extremity of the South Downs; *a defect* of matter towards the east immediately taking place. This circumstance renders the observations liable to some small errors, on account of the superior lateral attraction in the opposite direction; but, notwithstanding it is very probable that an error induced by either of these attractions, is so very small as to render the subject scarcely worth consideration, yet, as both lie *the same way*, it is satisfactory to consider that they mutually tend to correct the errors which may result from either; we may, therefore, safely conclude, that 1° 11′ 36″ is very nearly the true longitude between the station on Beachy Head and that on Dunnose. Under this persuasion, I consider it probable that the longitude of Black

Down cannot err in excess or defect more than 3″; that of Butterton 5″; and that of St. Agnes Beacon 6″.

The latitudes and longitudes of these important stations, brought under one point of view, will be as follows:

	Latitude.	Longitude west from Greenwich. In degrees.	In time.
Black Down -	50° 41′ 13″,8	2° 32″ 22″,4	10′ 9″,5
Butterton Hill -	50 24 46,3	3 52 47,5	15 31,2
St. Agnes Beacon	50 18 27	5 11 55,7	20 47,7

Note. It may probably be expected, that I should determine the directions of the meridians at Black Down, Butterton Hill, and St. Agnes Beacon, by calculation, and afterwards compare them with the observed ones. I have desisted from the measure in the body of the work, and reserved the little I have to say for this note.

If the earth were a perfect sphere, or an ellipsoid of known diameters, the direction of the meridian, at any station not very remotely situated from the parallel of another, might be determined, provided the direction of the meridian at that station were observed, and the value of the arc subtended by the space between them pretty accurately ascertained, and also the latitude of the station, at which the angle is given, nearly obtained.

Thus, if it be required to find the angle at Dunnose, between Beachy Head and the meridian, from the observed angle at the latter station, and the arc between them, we shall have 39° 15′ 36″,3, the co-latitude of Beachy Head, and 55′ 28″,7 for the oblique arc. These *data* (two sides and an included angle) give 1° 26′ 48″,4, for the difference of longitude between Beachy Head and Dunnose, and 81° 56′ 52″,6, for the angle which the meridian at the latter makes with the former station. The difference of longitude found in a rather more correct way, has been heretofore shewn to be 1° 26′ 47″,93, (see Philos. Trans. 1795, p. 523,) and the angle at Dunnose was also shewn to be 81° 56′ 53″, from observation, which may be considered the same with that found by this mode of computation. In all cases in which the *data* were equally correct, no doubt the direction of meridians might be computed, without fear of the results deviating much from the truth; but, if it be required to find the angle at Black Down, from the observed direction of the meridian at Dunnose, a different method must be used. It is, however, less accurate than the former one, and it has been expressly for this reason, that I have not introduced this subject into the account.

In the adjoining diagram, suppose B, Black Down; D, Dunnose; and, N, Nine Barrow Down: also, let PB, the meridian of Black Down, be prolonged to M, and DM be drawn, PM being = PD. Then we shall have three spherical triangles BPD, BND, and BMD. Now, the angle NBD was found from observations to be 4° 30′ 28″, and BND 172° 27′ 33″,5; these give the angle BDN = 3° 1′ 59″,5, nearly, because the excess of the three angles above 180° is 1″. The observed angle at D, Dunnose, between Nine Barrow Down and the meridian DP, or PDN, was 87° 56′ 53″; therefore, 87° 56′ 53″ — 3° 1′ 59″,5 = 84° 54′ 53″,5, is the angle at D, between the meridian and the station on Black Down.

Now, the difference of longitude between B and D, or the angle at P, has been already found = 1° 20′ 46″,4; and, since BP is very nearly = PD, and BD is small, we shall have rad. : tang. ½P :: cosine DP : cosine BMD = 89° 28′ 47″. But the angle PDB has been found = 84° 54′ 53″,5; therefore, 89° 28′ 47″ — 84° 54′ 53″,5 = 4° 33′ 53″,5, the angle BDM; hence, 180° 0′ 0″ — 94° 2′ 40″,5 = 85° 57′ 21″,5, or MBD; therefore, 94° 2′ 38″,5, or DBP, is the angle at Black Down obtained in this way, which differs nearly 16″ from the observed one, viz. 94° 2′ 22″,75. It is probable, some portion of this arises from defects in the observation made at Dunnose, on the lights fired at Nine Barrow Down: only two lights were seen; and, as the observations differed 5″ from each other, some degree of doubt exists, as to the accuracy of the angle. The angle at Nine Barrow Down, between Black Down and Dunnose, is not absolutely to be depended on for purposes of this kind, although there can be no doubt of its being sufficiently near the truth, for that to which it has been before applied. In the correction of the angles at that station, in our former accounts, we proceeded on the supposition of their being less satisfactory than the other angles of the triangles to which Nine Barrow Down is a common station. For these reasons, I am of opinion the computed angle cannot be applied as a test to the observed one; and it also appears to me, that greater objections lie against similar comparisons between the computed and observed angles at Butterton and St. Agnes; as those stations could not be seen from each other, nor the latter from Black Down. Although the computed directions of the meridians differ some seconds from the observed ones, I am by no means doubtful of the truth of the latter; as the double azimuths of the Pole Star, found from computation, agree very satisfactorily with those which have been used in obtaining the directions of the several meridians.——In finding the value of the oblique arc, or the line which joins Black Down and Dunnose, as used in the first method of computation, I have had recourse to the following *correct* expression, viz.

$$d = \frac{p\,m}{p + m - p \cdot s^2}\, s$$

where d is the length of the required degree, p that of the great circle perpendicular to the meridian, m that of a degree of the meridian itself, and s the sine of the angle constituted by the oblique arc and the meridian.

ART. XXV. *Bearings of the Stations in the Series of 1795 and 1796, from the Parallels to the Meridians of Black Down, Butterton Hill, and St. Agnes Beacon; likewise their Distances from those Meridians, and from their Perpendiculars.*

Meridian of Black Down.

Bearings from the Parallel to the Meridian.				Distances from merid.	Distances from perp.
		° ′ ″		Feet.	Feet.
Bull Barrow	Black Down	42 2 30	N E	53643.2	59489.7
Mintern		10 36 33	N E	10996.8	58709
Pilsden		56 14 48	N W	65775.6	43955.4
Charlton Common		83 30 3	N W	102681	11097.5
Dumpdon	Charlton Common	45 4 0	N W	143749	52670.9
Rippin Tor		81 37 52	S W		

Meridian of Butterton.

Rippin Tor	Butterton	27 0 25	N E	28585.3	56086.6
Furland		78 37 39	S E	78966.3	15883
Bolt Head		14 49 48	S E	18551.3	70065.4
Maker Heights		70 36 9	S W	71467.9	25164.3
Kit Hill		67 12 12	N W	93081.9	39121.7
Carraton Hill		73 53 22	N W	126408.9	30511.3
Cawsand Beacon	Rippin Tor	35 35 29	N W	86744.4	108147.5
Little Haldon	Furland	4 25 2	N E	84571.4	56676.8
Bindown	Maker	70 4 48	N W	52926.6	19180.1
Hensbarrow		87 35 18	S W	92878.0	28271.0

Meridian of St. Agnes Beacon.

Hensbarrow	St. Agnes Beacon	73 4 13	N E	92877.4	28279.9
Deadman		72 24 27	S E	97292.5	30849
Karnbonellis		3 27 27	S W	2741.7	45379.2
Karnminnis		61 13 58	S W	74168.1	40719
Bodmin } Lansallos }	Hensbarrow	37 30 45	N E	121703.2	65825.8
		75 29 51	S E	152945.3	12733.5
St. Burian	Karnbonellis	67 20 59	S W	94831.5	83807.3
Pertinney	Karnminnis	39 25 32	S W	100465.1	72704.4
Sennen	Pertinney	40 50 18	S W	113674.4	879868

ART. XXVI. *Latitudes and Longitudes of the Stations in the Series of 1795 and 1796.*

Meridian of Black Down.

Names of Stations.	Latitude.	Longitude from Black Down.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Bull Barrow	50 50 59,5	0 13 53,2 E	2 18 29,2	9 14
Mintern	50 50 52,8	0 2 50,8 E	2 29 31,6	9 58,1
Pilsden	50 48 26,9	0 17 0,7 W	2 49 23,1	11 17,5
Charton	50 43 6,1	0 26 30,5 W	2 58 52,9	11 55,5
Dunnpdon	50 49 47,2	0 37 12,1 W	3 39 34,5	14 38,3
Rippin Tor	50 33 59,1	1 13 3,8 W	3 45 26,2	15 1,7
Meridian of Butterton Hill.		From merid. of Butterton.		
Furland	50 22 7,8	0 23 13,2 E	3 32 34,3	14 10,3
Little Haldon	50 34 3,0	0 21 45,6 E	3 31 1,9	14 4,1
Cawsand Beacon	50 42 31,14	0 2 14,3 W	3 55 1,8	15 40,1
Bolt Head	50 13 15,2	0 4 44,5 E	3 48 3,1	15 12,2
Maker	50 20 36,56	0 18 18,2 W	4 11 5,7	16 44,3
Kit Hill	50 31 9,4	0 23 55,7 W	4 16 43,2	17 6,9
Carraton Hill	50 30 41,6	0 32 29,5 W	4 25 17,0	17 41,1
Bindown	50 23 32,9	0 31 53,5 W	4 24 41,0	17 38,7
Hensbarrow	50 23 3,3	0 55 20,2 W	4 48 7,7	19 12,5
Meridian of St. Agnes.		From merid. of St. Agnes.		
Lansallos	50 20 25,7	0 39 10,3 E	4 32 45,7	18 11,0
Bodmin Down	50 29 11,6	0 31 15,9 E	4 40 39,8	18 42,6
Deadman	50 13 20,0	0 24 51,3 E	4 47 4,4	19 8,3
Karnbonellis	50 10 59,4	0 0 42,0 W	5 12 37,7	20 50,5
Karnminnis	50 11 43,8	0 18 56,2 W	5 30 51,9	22 3,5
St. Burian	50 4 37,9	0 24 9,2 W	5 36 4,9	22 24,3
Pertinney	50 6 27,0	0 25 36,2 W	5 37 31,9	22 30,1
Sennen	50 3 55,6	0 28 56,7 W	5 40 52,4	22 43,5

ART. XXVII. *Bearings of the intersected Objects, from the Stations in the Series of 1795 and 1796, from the Parallels to the Meridians of Black Down, Butterton Hill, and St. Agnes Beacon; and likewise their Distances from these Meridians.*

Meridian of Black Down.

Bearings from the Parallels to the Meridian.					Distances from merid.	Distances from perp.
	°	′	″		Feet.	Feet.
At Bull Barrow.						
Portland Light House -	19	47	16	S E	21581	59985
Noil Windmill - -	10	12	56	N E	72842	166029
Noil Steeple - - - -	21	53	29	N E	86610	141534
Holy Trinity, - Shaftsbury	25	41	52	N E	81081	116506
St. Rumbold's Steeple, Ditto	28	12	51	N E	80486	109522
Maypowder Steeple - -	85	17	11	N W	29526	61479
Stourhead House - - -	0	27	46	N W	52881	153806
Mr. Frampton's Obelisk -	10	3	4	S E	63588	3384
Mere Steeple - - -	6	40	55	N E	63893	146984
Mrs. Thornhill's Obelisk -	22	18	51	N W	40391	91778
Odcomb Spire - -	70	25	0	N W	35474	91194
Milborne Port - - -	38	21	20	N W	20110	101865
At Black Down.						
Puncknoll Flagstaff -	89	9	57	N W	25612	373
Lambert's Castle - -	65	17	36	N W	67269	30950
Lyme Cobb - -	82	21	29	N W	89547	12015
At Pilsden.						
Golden Cape - -	4	44	3	S W	68239	14209
Glastonbury Tor - - -	14	19	23	N E	34314	167176
Bridport Beacon - -	8	19	55	S W	72199	91
Lord Rolle's Barn, near Sidmouth	64	34	38	S W	101743	26859
At Dumpdon.						
Naval Flagstaff, Whitlands -	32	45	10	S E	116249	9920
Catherstone Lodge - -	2	29	45	N E	140940	117131
Lord Lisburne's Obelisk -	46	47	34	S W	225502	24119
Sir J. de la Pole's Flagstaff - -	52	3	42	S E	86622	8137
Honiton Steeple - -	12	24	9	S W	146681	39339
St. Mary Ottery Steeple - -	42	21	56	S W	179904	13028
Sir Robert Palk's Tower -	58	56	2	S W	242012	6526

Meridian of Butterton.

Bearings from the Parallels to the Meridian.	°	′	″		Distances from merid.	Distances from perp.
					Feet.	Feet.
At Little Haldon.						
North Bovey	71	44	23	N W	43315	70289
Eastern Karn	56	27	52	N W	41145	85459
Western Karn	53	12	10	N W	40730	89472
West Down Beacon	63	59	14	N E	126152	76968
Woodley's Summer House	83	39	47	S W	29448	50555
Berry Head Flagstaff	10	22	16	S E	95740	4350
Brixen Steeple	2	29	4	S E	87435	9331
Ipplepen Steeple	22	15	0	S W	68413	17180
Three Barrow Tor	68	43	3	S W	8667	27109
Brent Beacon	56	11	17	S W	15460	10390
At Butterton.						
Chudleigh Steeple	44	4	44	N E	67688	69900
Froward Flagstaff	75	0	28	S E	84342	22587
Start Point Flagstaff	39	22	33	S E	56544	68897
Marlborough Steeple	16	42	32	S E	18429	61393
Bolt Head Flagstaff	14	57	7	S E	18739	70173
Mewstone, highest point	52	35	23	S W	49825	38108
Cupola, Hospital, Plymouth	76	47	30	S W	66891	15699
St. John's Steeple	79	34	44	S W	83991	15447
Saltash Steeple	89	37	12	S W	73707	489
Penlee Beacon	64	59	49	S W	69758	32532
Plymstock Steeple	73	46	15	S W	49217	14326
Slatten Barn	64	43	53	S W	53270	25145
Mount Batton	70	50	51	S W	58651	20370
Flagstaff, Plymouth Garrison	72	51	17	S W	57021	17591
New Church, Plymouth	75	25	49	S W	56521	14691
Old Church, Plymouth	75	1	56	S W	57505	15374
West Chimney, Governor's House	75	42	15	S W	64497	16435
Flagstaff on Mount Wise	75	40	55	S W	65281	16662
Chapel, Plymouth Dock	77	33	28	S W	67040	14792
Obelisk, Crimhill Passage, Plymouth	74	7	9	S W	66728	18984
Mount Edgecumbe House	72	18	23	S W	65827	21001
Flagstaff, Maker Tower	70	53	41	S W	68224	23632
Naval Signal Staff, Maker Tower	70	54	3	S W	68232	23626
Eddystone Light House	46	1	27	S W	87190	84127
At Butterton.						
Stonehouse Steeple	65	32	37	S W	53078	24140
Puslinch Obelisk	45	17	46	S W	27480	27223
Flagstaff, Rame Head	65	3	44	S W	76935	35774
At Rippin Tor.						
Great Haldon	52	27	0	N E	72023	89479

Bearings from the Parallels to the Meridian.	°	′	″		Distances from merid.	Distances from perp.
At Maker.					Feet.	Feet.
Hemmerdon Ball	62	10	37	N E	27722	2077
Brent Tor	5	27	45	N E	62385	69820
Blockhouse Flagstaff	27	51	26	N E	64005	11043
Rame Steeple	20	20	12	S W	74388	33043
Chapel, Dockyard	23	6	50	N E	67042	14795
Flagstaff, Statten Battery	88	9	5	S E	54278	25719
Windmill, Plymouth Dock	29	47	35	N E	65963	15549
At Kit Hill.						
St. Stephen's Steeple	19	29	31	S E	78182	2979
St. Ive Steeple	56	20	4	S W	114213	25047
Callington Steeple	43	0	14	S W	98219	33613
Linkinghorn Steeple	69	8	31	N W	111417	46108
St. Dominic Steeple	27	19	41	N E	89512	46030
South Petherwin Steeple	34	6	18	N W	115216	71807
South Hill	74	57	40	N W	108044	43142
St. Cleer Steeple	74	42	9	S W	133492	27795
At Carraton Hill.						
Cheese Rings	44	0	29	N W	131198	43540
Liskeard Steeple	15	19	39	S W	132155	15546
Landrake Steeple	46	1	2	S E	92463	3750
Duloe Steeple	15	23	3	S W	137923	5336
Menheniot Steeple	11	59	44	S E	121941	15479
Polparrow Flagstaff	20	8	5	S W	138871	2521
Lord Camelford's Obelisk	48	33	15	S W	163992	3324
Boconnock Steeple	44	34	58	S W	158753	3692
Roach Steeple	66	30	33	S W	218318	3434
Roach Rock	65	58	15	S W	217204	3969

Meridian of St. Agnes.

At Lansallos.						
Lanlivery Steeple	56	48	14	N W	119848	34388
Helmen Tor	53	55	17	N W	113818	41243
Mr. Tremaine's Summer House	67	21	40	S W	96548	10787
Gorran Steeple	58	55	59	S W	95877	21647
Flagstaff, Deadman	51	46	44	S W	97059	31278
Gwineas Rocks	53	9	0	S W	106551	22037
At Hensbarrow.						
Hendellion Steeple	2	26	59	N W	89918	97403
Stone, St. Braeg's Down	17	31	12	N W	81868	63145
St. Dennis Steeple	83	6	25	N W	77630	30114
Lansallos Steeple	73	43	28	S E	149787	11656
Gerrans Steeple	26	33	53	S W	55357	46773
St. Michael Carhayes Steeple	9	39	51	S W	84768	19353

Bearings from the Parallels to the Meridian.	°	′	″		Distances from merid.	Distances from perp.
					Feet.	Feet.
St. Kivern Steeple	27	6	7	S W	30611	93398
Flagstaff, Blackhead	24	50	36	S W	31214	104917
Windmill, near Fowey	67	2	44	S E	134347	10727
Menabilly House	60	26	48	S E	123516	10899
Old Tower at Polruan	64	44	37	S E	35892	7978
Flagstaff, St. Anthony's Head (D.*)	26	35	45	S W	48664	60038
At the Deadman.						
St. Veep's Steeple	39	4	29	N E	140146	21930
At St. Agnes.						
St. Columb Minor Steeple	44	7	57	N E	46698	41950
Peranzabulo	41	54	34	N E	19354	21503
St. Eval Steeple	37	52	39	N E	50275	64032
Cubert Steeple	42	26	53	N E	23773	25991
Flagstaff, Pendennis Castle	34	19	23	S E	39999	58586
Windmill, St. Mawe's	45	52	9	S E	48079	46642
Karnbre Castle	11	53	47	S W	6480	30760
Illugan Steeple	30	1	2	S W	11865	20537
St. Paul's Steeple	20	21	16	S W	38457	103600
Lord Dunstanville's House	40	33	25	S W	19726	23050
Gwinear Steeple	39	33	34	S W	39578	47911
Cow and Calf	23	7	32	N E	37174	87044
Camborn Steeple	30	16	51	S W	19881	34048
St. Erme Steeple	88	42	22	N E	44657	1009
St. Allen Steeple	85	13	35	N E	36688	3064
Ludgvan Steeple	47	39	58	S W	64737	58976
At Karnbonellis.						
Lizard Windmill	1	47	24	S E	573	114785
Grade Steeple	6	41	17	S E	5710	117451
Ruan Major Steeple	3	46	21	S E	1486	100496
St. Hilary Steeple	60	19	33	S W	49009	65064
Mr. Rogers's Tower, near St. Ives	83	43	6	S W	18396	47102
Madern Steeple	76	53	40	S W	81542	63725
Parklough Flagstaff	6	55	11	S W	10735	111240
At Karnminnis.						
St. Buryan Steeple	25	45	25	S W	95205	84320
At St. Buryan.						
Chapel Karnbury	3	25	16	N W	95472	73098
Flagstaff, St. Leven's Point	77	29	40	S W	114449	88158
Sennen Steeple	83	44	37	S W	112202	85712
At Pertinney.						
Stone, Land's End	48	5	30	S W	116222	86847

* The letter D is added (as in the former accounts) to those places respecting which any doubts are entertained.

ART. XXVIII. *Latitudes and Longitudes of such intersected Objects, in the Series of 1795 and 1796, as have been referred to the Meridians of Black Down, Butterton Hill, and St. Agnes.*

Names of Objects.	Latitude	Longitude from Black Down.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Portland Light House -	50 31 22,2	0 5 32,9 E	2 26 49,5	9 47,3
Noil Windmill - -	51 8 29,3	0 18 58,7 E	2 13 23,7	8 53,6
Noil Steeple - -	51 4 27,1	0 22 31,8 E	2 19 50,6	9 19,3
Holy Trinity, - Shaftsbury	51 0 20,7	0 21 3,6 E	2 11 18,8	8 45,3
St. Rumbold's Steeple, Ditto	50 59 11,8	0 20 53,9 E	2 11 28,5	8 45,8
Maypowder Steeple -	50 51 19,7	0 7 38,6 E	2 24 43,8	9 38,9
Stourhead House - -	51 6 29,5	0 13 46,0 E	2 18 36,4	9 14,4
Mr. Frampton's Obelisk -	50 41 46,0	0 16 24,5 E	2 15 57,9	9 3,8
Mere Steeple - -	51 5 21,7	0 16 37,6 E	2 15 44,8	9 2,9
Mrs. Thornhill's Obelisk -	50 56 17,5	0 10 28,6 E	2 21 53,8	9 27,6
Odcomb Spire - -	50 56 12,6	0 9 12,1 W	2 41 34,4	10 46,3
Milborne Port - -	50 57 58,0	0 5 13,1 E	2 27 9,3	9 48,6
Puncknoll Flagstaff -	50 41 17,3	0 6 36,4 W	2 38 58,8	10 35,9
Lambert's Castle - -	50 46 17,7	0 17 23,1 W	2 49 45,5	11 19
Lyme Cobb - -	50 43 10,0	0 23 7, W	2 55 29,4	11 41,9
Golden Cape - -	50 43 32,5	0 17 37,2 W	2 49 59,6	11 20
Glastonbury Tor - -	51 8 47,7	0 8 56,4 W	2 41 18,8	10 45,2
Bridport Beacon - -	50 41 13,2	0 18 37,6 W	2 50 59,9	11 24
Ld. Rolle's Barn, near Sidmouth	50 45 35,6	0 26 17,2 W	2 58 39,6	11 54,6
Naval Flagstaff, Whitlands	50 42 47,7	0 30 0,4 W	3 2 22,8	12 9,5
Catherstone Lodge - -	51 0 23,0	0 36 36,6 W	3 8 59,0	12 35,9
Lord Lisburne's Obelisk -	50 37 1,3	0 58 5,6 W	3 30 28,1	14 1,9
Sir J. de la Pole's Flagstaff -	50 42 31,9	0 22 21,4 W	2 54 43,8	11 38,9
Honiton Steeple - -	50 47 35,5	0 37 55,7 W	3 10 18,1	12 41,2
St. Mary Ottery Steeple -	50 43 12,9	0 46 26,8 W	3 18 49,2	13 15,3
Sir Robert Palk's Tower -	50 39 52,5	1 2 24,6 W	3 34 47,	14 19,1

Meridian of Butterton Hill.

Names of Objects.	Latitude.	Longitude from Butterton Hill.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
North Bovey Steeple (D.)	50 36 18,7	0 11 9,3 E	3 41 38,2	14 46,5
Eastern Karn	50 38 48,4	0 10 36,3 E	3 42 11,2	14 48,7
Western Karn	50 39 27,9	0 10 30,1 E	3 42 17,4	14 49,1
West Down Beacon	50 37 20,5	0 32 30,0 E	3 20 17,5	13 21,1
Woodley's Summer House	50 33 4,5	0 7 34,5 E	3 45 13	15 0,9
Flagstaff, Berry Head, Torbay	50 24 0,7	0 24 33,1 E	3 28 14,4	13 52,9
Brixen Steeple	50 23 12	0 22 24,8 E	3 30 22,7	14 1,5
Ipplepen Steeple	50 27 34,2	0 17 33,8 E	3 35 13,7	14 20,9
Three Barrow Tor	50 29 13,5	0 2 13,5 E	3 50 34	15 22,3
Brent Beacon, near Ashburton	50 26 28,6	0 3 58,1 E	3 48 49,4	15 15,3
Chudleigh Steeple	50 36 14,1	0 17 25,9 E	3 35 21,6	14 21,4
Froward Flagstaff	50 21 1,4	0 21 36,3 E	3 31 11,2	14 4,7
Flagstaff, Start Point	50 13 25,9	0 14 26,7 E	3 38 20,8	14 33,4
Marlborough Steeple	50 14 40,7	0 4 42,5 E	3 48 5,0	15 12,3
Flagstaff, Bolt Head	50 13 14,1	0 4 47,2 E	3 48 0,3	15 12
Mewstone, highest point	50 18 29,7	0 12 45,1 W	4 5 32,6	16 22,1
Cupola of Plymouth Hospital	50 22 10,1	0 17 8,5 W	4 9 56,1	16 39,7
St. John's Steeple (D.)	50 22 11,8	0 21 31,4 W	4 14 18,9	16 57,2
Saltash Steeple	50 24 39,8	0 18 54,3 W	4 11 41,8	16 42,8
Penlee Beacon	50 19 24	0 17 52,6 W	4 10 40,1	16 42,7
Plymstock Steeple	50 22 24,2	0 12 36,8 W	4 5 24,3	16 21,6
Staiten Barn	50 20 37,4	0 13 38,6 W	4 6 26,1	16 25,7
Mount Batten	50 21 24,3	0 15 1,6 W	4 7 49,1	16 31,2
Flagstaff, Plymouth Garrison	50 21 21,8	0 14 36,5 W	4 7 24,0	16 29,6
New Church, Plymouth	50 22 20,4	0 14 29,0 W	4 7 16,5	16 29,1
Old Church, Plymouth	50 22 13,6	0 14 44,1 W	4 7 31,6	16 30,1
Eddystone Light House	50 10 54,5	0 22 15,4 W	4 15 2,9	17 0,3
West Chimney, Governor's House, Plymouth Dock	50 22 2,9	0 16 31,6 W	4 9 19,1	16 37,2
Flagstaff, Mount Wise	50 22 0,7	0 16 43,7 W	4 9 31,2	16 38,1
Chapel, Plymouth Dock	50 22 19	0 17 10,8 W	4 9 58,3	16 39,9
Obelisk, Crimhill Passage	50 21 37,7	0 17 5,8 W	4 9 53,3	16 39,5
Mount Edgecumbe House	50 21 17,9	0 16 51,8 W	4 9 39,3	16 38,6
Flagstaff, Maker Tower	50 20 51,8	0 17 28,5 W	4 10 16,0	16 41,1
Naval Flagst. near Maker Tow.	50 20 51,9	0 17 28,6 W	4 10 16,1	16 41,1
Stonehouse Steeple	50 20 47,4	0 13 35,7 W	4 6 23,2	16 25,5
Puslinch Obelisk	50 20 17,5	0 7 2,6 W	3 59 50,1	15 59,5
Rame Head	50 18 51,7	0 19 41,5 W	4 12 29,0	16 49,9
Great Haldon	50 39 27	0 18 34,2 W	3 34 13,3	14 16,9
Hemmerdon Ball	50 21 21,2	0 7 6,5 W	3 59 53,6	15 59,5
Brent Tor	50 36 13,4	0 16 33,9 W	4 9 21,4	16 37,4
Flagstaff, Blockhouse, Plymouth	50 22 56,4	0 16 24,4 W	4 9 11,8	16 36,8

Names of Objects.	Latitude.	Longitude from Butterton Hill.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Rame Steeple	50 19 18,7	0 37 59,8 W	4 30 47,3	18 3,1
Flagstaff, Staiten Battery	50 20 31,8	0 13 54,1 W	4 6 41,6	16 26,8
Windmill, Plymouth Dock	50 22 11,6	0 16 54,2 W	4 9 41,7	16 38,8
St. Stephen's Steeple	50 24 15,1	0 20 3,0 W	4 12 50,5	16 51,3
St. Ive Steeple	50 28 49	0 29 20,2 W	4 22 7,7	17 28,5
Linkinghorn Steeple	50 32 17,3	0 28 39,2 W	4 21 26,7	17 25,8
St. Dominic Steeple (D.)	50 32 17,8	0 23 1,2 W	4 15 48,7	17 3,2
South Petherwin Steeple	50 36 30,4	0 29 40,4 W	4 22 27,5	17 29,8
South Hill Steeple	50 31 48,3	0 27 46,9 W	4 20 34,4	17 22,3
St. Cleer Steeple	50 29 15	0 34 33,1 W	4 27 20,6	17 49,4
Callington Steeple	50 30 14,9	0 25 14,4 W	4 18 1,9	17 12,1
Cheese Rings	50 31 50,5	0 34 14,9 W	4 27 2,4	17 48,1
Liskeard Steeple	50 27 14,4	0 33 55,5 W	4 26 43,0	17 46,8
Landrake Steeple	50 25 20,7	0 23 43,3 W	4 16 30,8	17 6
Duloe Steeple	50 23 48,0	0 35 21,9 W	4 28 9,4	17 52,6
Menheniot Steeple	50 27 14,5	0 31 18,3 W	4 24 5,8	17 36,4
Pulparrow Flagstaff	50 25 5,5	0 35 37,4 W	4 28 24,9	17 53,6
Lord Camelford's Obelisk	50 25 11,1	0 42 4,2 W	4 34 51,7	18 19,4
Boconnock Steeple	50 25 15,3	0 40 43,7 W	4 33 31,2	18 14,1
Roach Rock	50 23 53,4	0 55 41,8 W	4 48 29,4	19 13,9
Roach Steeple	50 23 58,7	0 55 59,1 W	4 48 46,6	19 15,1

Meridian of St. Agnes.

Names of Objects.	Latitude.	Longitude from St. Agnes Beacon.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Lanlivery Steeple	50 24 1,9	0 30 44,0 E	4 41 11,7	18 44,8
Helmen Tor	50 25 9,9	0 29 11,9 E	4 42 43,8	18 50,9
Mr. Tremaine's Summer House	50 16 37,8	0 24 41,6 E	4 47 14,1	19 8,9
Gorran Steeple	50 14 50,8	0 24 30,4 E	4 47 25,3	19 9,6
Flagstaff, Deadman	50 13 15,8	0 24 47,7 E	4 47 8,0	19 8,5
Gwineas Rocks	50 14 46,3	0 27 14,1 E	4 44 41,6	18 58,8
Hendellion Steeple	50 34 25,6	0 23 8,5 E	4 48 47,2	19 15,1
Stone, St. Braeg's Down	50 28 47,6	0 21 1,7 E	4 50 54,0	19 23,6
St. Dennis Steeple	50 23 22,1	0 19 54,1 E	4 52 1,6	19 28,1
St. Michael Carhayes Steeple	50 15 14,0	0 21 40,2 E	4 50 15,5	19 21
St. Kivern Steeple	50 3 5,6	0 7 47,5 E	5 4 8,2	20 16,5
Flagstaff, Blackhead	50 1 12,1	0 7 56,4 E	5 3 59,3	20 15,9
Windmill, near Fowey	50 20 7,2	0 34 24,2 E	4 37 31,5	18 30,1
Menabilly House	50 20 9,9	0 31 37,8 E	4 40 17,9	18 4,11
Old Tower at Polruan	50 19 40,2	0 34 47,7 E	4 37 8,0	18 28,5
Flagstaff, St. Anthony's Head	50 8 34,2	0 12 24,7 E	4 59 31,0	19 58,1
St. Veep's Steeple	50 21 57,5	0 35 54,7 E	4 36 1,0	18 24,1
St. Columb Minor Steeple	50 25 20,1	0 10 26,4 E	5 1 29,3	20 5,9
Peranzabulo	50 21 59,4	0 4 57,6 E	5 6 58,2	20 27,9

Names of Objects.	Latitude.	Longitude from St. Agnes Beacon.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
St. Eval Steeple	50 29 3,5	0 12 54,9 E	4 59 0,8	19 56
Cubert Steeple	50 22 43,0	0 6 5,6 E	5 5 50,1	20 23,3
Flagstaff, Pendennis Castle	50 8 48,7	0 10 12,1 E	5 1 43,6	20 6,9
Windmill, St. Mawes	50 10 46,3	0 12 16,3 E	4 59 39,4	19 58,6
Karnbre Castle	50 13 23,6	0 1 39,3 W	5 13 35,0	20 54,3
Illugan Steeple	50 15 4,4	0 3 1,9 W	5 14 57,6	20 59,8
St. Paul's Steeple	50 1 24,3	0 9 47,0 W	5 21 42,7	21 26,8
Lord Dunstanville's House	50 14 39,4	0 5 2,5 W	5 16 58,2	21 7,8
Lansallos Steeple	50 20 15,3	0 38 16,2 E	4 33 39,5	18 14,6
Gerrans Steeple	50 10 44,8	0 14 7,7 E	4 57 48,0	19 51,2
Gwinear Steeple	50 10 34,	0 10 6,0 W	5 22 1,7	21 28,1
Cow and Calf	50 32 44,8	0 9 33,7 E	5 2 22,0	20 9,5
Camborn Steeple	50 12 51,0	0 5 4,7 W	5 17 0,4	21 8
St. Erme Steeple	50 18 36,3	0 11 25,7 E	5 0 30,0	20 2
St. Allen Steeple	50 18 56,8	0 9 23,6 E	5 2 32,1	20 10,1
Ludguan Steeple	50 8 44,1	0 16 30,7 W	5 28 26,4	21 53,8
Windmill, Lizard	49 59 35,1	0 0 8,7 E	5 12 4,4	20 48,3
Grade Steeple	49 59 8,8	0 1 27,1 E	5 10 28,6	20 41,9
Ruan Major Steeple	50 0 27,2	0 0 22,6 E	5 11 29,1	20 45,9
St. Hilary Steeple	50 7 38,7	0 12 39,7 W	5 24 25,4	21 37,7
Mr. Rogers's Tower	50 10 42,4	0 4 41,7 W	5 16 37,4	21 6,5
Madern Steeple	50 7 56,6	0 20 47,5 W	5 32 43,2	22 10,9
Park Lough Flagstaff	50 0 9,9	0 2 43,8 W	5 14 39,5	20 58,6
Lizard Flagstaff	49 57 55,8	0 0 38,1 E	5 11 17,7	20 45,2
St. Buryan Steeple	50 4 32,8	0 24 14,8 W	5 36 10,5	22 24,7
Karnbury Chapel	50 6 23,5	0 24 19,8 W	5 36 15,5	22 25
St. Leven's Point, Flagstaff	50 3 53,8	0 29 8,5 W	5 41 4,2	22 44,3
Sennen Steeple	50 4 18,0	0 28 36,6 W	5 40 29,9	22 41,9
Stone, Land's End	50 4 6,6	0 29 35,8 W	5 41 31,5	22 46,1

Notwithstanding almost the whole of the above latitudes and longitudes belong to objects near the sea coast, yet I have distinguised those which are actually upon it, from those more remotely situated, by *Italics*.

ART. XXIX. *Bearings of the Stations in the Series of* 1797 *and* 1798, *from the Parallels to the Meridians of Black Down, Butterton Hill, and St. Agnes Beacon; and likewise their Distances from those Meridians.*

Meridian of Black Down.

Names of the Stations.		Bearings.	Distances from merid.	Distances from perp.
		° ′ ″	Feet.	Feet
Pilsden	Moor Lynch	2 33 59 NW	71070	162067
Ash Beacon		59 58 59 NW		
Mintern	Ash Beacon	5 17 18 NW	5544	117624
Moor Lynch		59 53 1 SE		
Bull Barrow	Long Knoll	1 2 34 NE	55557	164653
Ash Beacon		46 45 33 NE		
Pilsden	Dundon	12 40 33 NE	42964	145377
Moor Lynch		59 17 35 SE		
Moor Lynch	Mendip	66 3 36 NE	1021	194072
Ash Beacon		3 23 8 NW		
Long Knoll	Beacon Hill	82 28 4 NE	189665	182386
Wingreen		50 16 22 NW		
Long Knoll	Westbury	39 44 34 NE	92715	209344
Mendip		80 32 31 NE		
Westbury	Farley Down	35 44 37 NW	57752	257920
Dundry		88 51 23 SE		
Mendip	Dundry	18 59 1 NW	21488	259503
Farley Down		88 51 22 NW		
Mendip	Lansdown	22 4 57 NE	32440	271514
Dundry		77 26 41 NE		

Meridian of Butterton Hill.

Carraton Hill	St. Stephen's	15 15 47 NE	112457	87635
Kit Hill		21 46 9 NW		
Carraton Hill	Black Down	64 12 55 NE	51797	72555
St. Stephen's		76 2 26 SE		

Meridian of St. Agnes Beacon.

St. Agnes Beacon	Trevose Head	25 54 12 NE	42858	88250
Hensbarrow		39 49 34 NW		
Trevose Head	Cadon Barrow	63 18 48 NE	119364	126702
Bodmin Down		2 11 52 NW		
Bodmin Down	Brown Willy	28 46 20 NE	142745	104145
Cadon Barrow		46 1 42 SE		

ART. XXX. *Bearings of the Stations in the Series of 1799, from the Parallels to the Meridians of Dunnose and Greenwich; and likewise their Distances from those Meridians.*

Meridian of Dunnose.

Names of the Stations.		Bearings.	Distances from merid.	Distances from perp.
		° ′ ″	Feet.	Feet.
Highclere	Bagshot Heath	81 40 58 NE	108275	274173
	Nuffield	35 30 40 NE	36747	351480
	White Horse Hill	27 47 37 NW	83796	349533
White Horse Hill	Stow on the Wold	14 29 27 NW	114915	409942
	Brill	50 16 17 NE	28955	443235
	Shotover Hill	53 30 7 NE	3063	413801
	Scutchamfly	84 25 51 SE	32776	344558
	Whiteham Hill	36 30 13 NE	31054	420801
Stow on the Wold	Broadway	33 3 55 NW	143396	513693
	Epwell	39 34 55 NE	64617	530781
Shotover Hill	Cumner Hill	76 58 3 SW	25416	407209
Epwell	Corley Hill	6 39 56 NW	81312	673657
	Arbury Hill	48 5 23 NE	2776	586288
Brill	Crouch Hill	39 20 49 NW	36102	522584
	Quainton	61 40 13 NE	64963	462648

Meridian of Greenwich.

Nuffield	Wendover	44 48 19 NE	174338	100986
Brill		65 49 3 SE		
Brill	Bow Brickhill	56 46 9 NE	151413	190493
Arbury Hill		54 50 52 SE		
Brill	Kinsworth	85 8 30 NE	120910	141562
Bow Brickhill		31 55 51 SE		
Bow Brickhill	Lillyhoe	74 6 27 SE	84215	171367
Kinsworth		50 54 40 NE		
Bow Brickhill	Lidlington	67 24 37 NE	121834	202802
Lillyhoe		50 6 55 NW		
Bow Brickhill	Trusler Hill	89 1 15 SE	131278	190151
Lillyhoe		68 14 71 NW		

ART. XXXI. *Latitudes and Longitudes of the Stations in the Series of 1797 and 1798, referred to the Meridians of Black Down, Butterton Hill, and St. Agnes Beacon.*

Meridian of Black Down.

Names of the Stations.	Latitude.	Longitude from Black Down.	Longitude west of Greenwich. In degrees.	Longitude west of Greenwich. In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Moor Lynch	51 7 50,2	0 18 30,6 W	2 50 53	11 23,5
Ash Beacon	51 0 33,5	0 1 26,4 E	2 30 56	10 5,7
Long Knoll	51 8 10,2	0 14 28,3 E	2 17 54,1	9 11,6
Dundon	51 5 6,5	0 11 10,7 W	2 43 33,1	10 54,2
Mendip	51 13 7,2	0 0 15,9 E	2 32 6,5	10 8,4
Beacon Hill	51 11 1,6	0 49 20,6 E	1 43 1,8	6 52,1
Westbury	51 15 35,3	0 24 13 E	2 8 9,4	8 32,6
Farley Down	51 23 35,7	0 15 7,6 E	2 17 14,8	9 8,9
Dundry	51 23 52,2	0 5 37,7 W	2 38 0,1	10 32,0
Lansdown	51 27 50,4	0 8 30,6 E	2 23 51,8	9 35,4

Meridian of Butterton Hill.

Names of the Stations.	Latitude.	Longitude from Butterton Hill.	Longitude west of Greenwich. In degrees.	Longitude west of Greenwich. In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
St. Stephen's	50 39 0,7	0 28 59,6 W	4 21 47,1	17 27,1
Black Down	50 36 40,9	0 13 20,5 W	4 6 8,0	16 24,5

Meridian of St. Agnes Beacon.

Names of the Stations.	Latitude.	Longitude from St. Agnes Beacon.	Longitude west of Greenwich. In degrees.	Longitude west of Greenwich. In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Trevose Head	50 32 56,5	0 11 1,5 E	5 0 54,2	20 3,6
Cadon Barrow	50 39 12,1	0 30 46,5 E	4 41 9,2	18 44,6
Brown Willy	50 35 27,9	0 36 45,3 E	4 35 10,4	18 20,6

ART. XXXII. *Latitudes and Longitudes of the Stations in the Series of* 1799, *referred to the Meridians of Dunnose and Greenwich.*

Meridian of Dunnose.

Names of the Stations.	Latitude.	Longitude from Dunnose.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Nuffield	51 34 52,2	0 9 39,9 E	1 1 56,1	4 7,7
White Horse Hill	51 34 31,6	0 22 1,7 W	1 33 37,7	6 14,5
Stow on the Wold	51 54 16,3	0 30 26,7 W	1 42 2,4	6 48,1
Broadway	52 1 25,6	0 38 5,3 W	1 49 41,3	7 18,7
Brill	51 49 56,6	0 7 39,4 E	1 3 56,6	4 15,7
Scutchamfly	51 33 44,1	0 8 37 W	1 20 13,0	5 20,8
Shotover Hill	51 45 6,7	0 0 48,5 E	1 10 47,5	4 43,1
Whitcham Hill	51 46 15,4	0 8 12,1 W	1 19 48,1	5 19,2
Cumner Hill	51 44 1,5	0 6 42,4 W	1 18 18,4	5 13,2
Epwell	52 4 19,8	0 17 10,8 W	1 28 46,8	5 55,1
Corley Hill	51 50 28,3	0 9 39,9 W	1 21 15,9	5 25,0
Arbury Hill	52 13 26,6	0 0 44,4 W	1 12 20,4	4 49,3
Crouch Hill	52 2 58,7	0 9 35,6 W	1 21 11,6	5 24,7
Quainton	51 53 7,2	0 17 12,1 E	0 54 23,9	3 37,6

Meridian of Greenwich.

Names of the Stations.	Latitude.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	m. s.
Wendover	51 45 6,4	0 46 1,4	3 4,1
Bow Brickhill	51 59 50,5	0 40 1,2	2 44,1
Kinsworth	51 51 50,8	0 31 59,9	2 7,9
Lillyhoe	51 56 46,5	0 22 19,5	1 29,3
Lidlington	52 1 54,0	0 32 21,7	2 9,4
Trusler Hill	51 59 48,0	0 34 50,5	2 19,3

ART. XXXIII. *Bearings of intersected Objects, from the Stations in the Series of 1797 and 1798, from the Parallels to the Meridians of Black Down, Butterton Hill, and St. Agnes Beacon; and likewise their Distances from those Meridians.*

Meridian of Black Down.

Bearings from the Parallels to the Meridian.	°	′	″		Distances from merid.	Distances from perp.
					Feet.	Feet.
At Moor Lynch.						
Walton Windmill	75	12	31	S E	51340	156858
Westonzoyland Steeple	63	42	36	S W	46928	154235
Middlezoy Steeple	31	48	21	S W	79339	148733
Chedzoy Steeple	85	18	45	N W	90459	163658
Higham Windmill	29	57	17	S E	58858	140880
Higham Steeple	22	51	39	S E	62691	142196
Bridgewater Spire	88	39	25	S W	104717	161280
Somerton Steeple	47	4	54	S E	41197	134292
Burton Pynsent Obelisk	10	35	4	S W	78428	122688
At Dundry.						
Puckle Steeple	55	19	25	N E	26010	292363
Westleigh Steeple	46	49	23	N E	23610	301818
Bristol Cathedral	26	7	30	N E	11836	279184
Redcliff Steeple	33	8	32	N E	9407	278007
Long Aston	0	51	38	N W	21696	273385
Clifden Windmill	9	52	50	N E	19281	272172
Blaze Castle	1	49	16	N E	20268	297874
Penpole Park Gazebo	11	43	37	N W	28680	294155
Duke of Beaufort's House, Stoke	32	31	51	N E	651	294212
Durham Steeple	63	28	33	N E	38049	289219
Knowle Steeple	13	41	30	N E	8112	314410
Mangotsfield Steeple	47	44	31	N E	13923	291677
Winterbourn Steeple	31	14	10	N E	7056	306569
Harfield Steeple	20	12	9	N E	93478	292526
Leigh on Mendip	33	59	55	S E	21483	195794
Dundry Steeple	71	23	20	S W	22831	259052
At Long Knoll.						
Doulting Spire	68	59	51	N W	9544	182322
Frome Steeple	5	20	25	N W	52415	198272
At Farley Down.						
Devizes Steeple	79	51	30	S E	129342	245113
Cold Aston Steeple	33	43	21	N W	44362	277983

Meridian of Butterton Hill.

Bearings from the Parallels to the Meridian.					Distances from merid.	Distances from perp.
	°	′	″		Feet.	Feet.
At Furland.						
Hope's Nose	23	7	55	N E	93759	18745
At St. Stephen's.						
Werrington Steeple	29	37	23	N E	109839	93242
Boyton Steeple	0	55	35	N W	112767	106733
St. Stephen's Steeple	45	55	4	S E	110738	85968
North Petherwin Steeple	49	15	49	N W	125044	98473
At Carraton Hill.						
Stokeclimsland Steeple	65	56	2	N E	96381	49922
Launceston Steeple	21	26	54	N E	108267	82689
Launceston Chapel	21	14	13	N E	108513	82561

Meridian of St. Agnes Beacon.

At Bodmin.						
St. Minvern Steeple	58	18	36	N W	79549	91845
St. Minvern Windmill	61	51	46	N W	90966	82260
At Trevose Head.						
St. Isey Steeple	61	2	12	S E	68456	74082
St. Merian Steeple	57	59	32	S E	52096	82476

ART. XXXIV. *Bearings of intersected Objects, from the Stations in the Series of 1799, from the Parallels to the Meridians of Dunnose and Greenwich; and likewise their Distances from those Meridians.*

Meridian of Dunnose.

At Epwell.						
Warwick Steeple	16	25	48	N W	87242	607508
St. Martin's, Coventry	2	3	42	N W	69028	653327
Soleyhul Spire	31	8	35	N W	128826	654971
At Arbury Hill.						
Dunchurch Windmill	23	55	48	N W	20724	626734
Breadon Hill, Summer House	7	37	31	N W	26706	765038

Bearings from the Parallels to the Meridian.	°	′	″		Distances from merid.	Distances from perp.
					Feet.	Feet.
Markfield Windmill	5	20	7	NW	18608	755819
Newnham Windmill	59	36	2	NE	2261	589244
At Corley Hill.						
Gazebo, Breadon Hill	35	45	58	SW	188086	525408
At Crowch Hill.						
Deddington Steeple	18	6	0	SE	28646	499771
Bloxham Spire	16	35	11	SW	39519	511110
Aynoe Steeple	49	26	2	SE	11944	501902
Adderbury Spire	37	26	59	SE	26213	509671
Farthingo Steeple	56	26	49	SE	6431	502904
At Arbury Hill.						
Round House, Edge Hills	56	15	5	SW	57501	549724
Windmill, near the Round House	55	39	29	SW	58398	548286
At Brill.						
Wingrove Steeple	81	17	5	NE	103826	454713
Hardwick Steeple	78	6	1	NE	83299	454687
Luggersal Steeple	44	56	1	NE	35106	419401
Granborough Steeple	53	9	30	NE	70782	474574
Bicester Steeple	43	27	16	NW	6854	466560
Marq. Buckingham's House, Wooton	79	17	25	NE	43490	445984
Islip Steeple	84	26	3	SW	8944	439540
Woodstock Steeple	85	25	45	NW	35563	448393
Kidlington Spire	88	29	39	SW	18401	441989
Witchwood Beacon	89	11	34	SW	76971	444726
At Whiteborse Hill.						
Abingdon Spire	62	38	18	NE	19054	383037
Wallingford Steeple	84	54	39	NE	17497	358560
Great Coxwell Windmill	25	45	11	NW	96959	376819
Drayton Steeple	67	28	0	NE	24691	374055
Highworth Steeple	57	49	58	NW	116343	370003
Witney Spire	14	14	57	NE	64787	424386
Bampton Steeple	4	36	29	NE	79056	408334
Radley Steeple	61	25	12	NE	12123	388578
Buckland Steeple	20	8	12	NE	69616	388204
At Stow.						
Stow on the Wold Steeple	20	55	25	NW	118442	479166
At Broadway.						
Sarsden Chapel	52	29	8	SE	86195	469777
Bourton Chapel	54	36	35	SE	125636	501076
Walford Spire	22	38	42	SE	98704	507924

Meridian of Greenwich.

Bearings from the Parallels to the Meridian.	°	′	″		Distances from merid.	Distances from perp.
					Feet.	Feet.
At Wendover.						
Pitchcot Windmill	19	11	59	N W	191077	149055
Ivinghoe Spire	45	44	37	N E	143127	131397
Quainton Steeple	34	47	15	N W	205750	146203
Leighton Buzzard Spire	21	41	12	N E	150616	160663
At Quainton.						
Southern Obelisk, Stow Park	22	1	36	N W	227554	204673
Northern Obelisk, ditto	21	50	48	N W	228505	207532
At Kinsworth.						
Aylesbury Spire	77	56	58	S W	190234	126763
Maulden Steeple	16	30	28	N E	102962	202124
Harlington Steeple	16	12	37	N E	110395	177730
Millbrook Steeple	3	1	41	N E	117732	201645
Stretley Steeple	35	23	47	N E	99961	171044
Sauldon Windmill	60	20	46	N W	178643	174431
At Bow Brickhill.						
Hanslope Spire	38	58	48	N W	185668	232843
North Crawley Steeple	9	41	15	N E	145529	224961
Pavenham Spire	22	15	49	N E	122215	261812
St. Paul's Spire, Bedford	43	9	11	N E	104408	240631
Sharnbrook Spire	19	21	54	N E	123533	269816
Woburn Market-House	73	52	37	S E	139255	186978
Ridgemont Station	72	28	11	N E	130927	196964
Wootton Spire	41	33	7	N E	120265	225635
Cranfield Spire	30	44	22	N E	136284	215933
Husborne Crawley Steeple	65	44	51	N E	136827	197064
Woburn Steeple	75	33	58	S E	139373	187394
Souldrope Spire	16	32	49	N E	124861	279861
Windmill near Tharfield	86	6	12	N E	12577	199950
Tottenhoe Station	27	42	7	S E	130412	150494
Chalgrave Steeple	53	51	5	S E	116215	164780
Keysoe Spire	31	17	59	N E	95682	282155
Moulshoe Steeple	2	19	30	N W	152432	215608
Renhold Spire	44	56	16	N E	91651	250385
Lidlington Windmill	62	30	6	N E	125855	203797
At Lillyboe.						
Knotting Green Elm Tree	16	17	56	N W	117482	285139
Ravensden Steeple	7	25	2	N W	95142	255304
Bow Brickhill Steeple	73	20	18	N W	151490	191501

Bearings from the Parallels to the Meridian.	° ′ ″	Distances from merid.	Distances from perp.
		Feet.	Feet.
Colmworth Spire	0 12 52 N W	84580	268984
Sundon Windmill	75 0 6 S W	109032	164718
Silsoe Steeple	26 9 25 N W	95501	194345
Flitton Steeple	38 20 32 N W	102831	194903
Shillington Steeple	7 49 43 N E	81919	188066
Westoning Steeple	64 42 19 N W	113366	185143
Wrest-Garden Obelisk	26 26 8 N W	94797	192652
Flitwick Steeple	57 11 27 N W	114694	191016
Ampthill Steeple	39 6 3 N W	109957	203041
St. Neot's Steeple	13 32 16 N E	59630	273475
Pollux Hill Steeple	47 5 30 N W	102236	188118

ART. XXXV. *Latitudes and Longitudes of such Places, in the Series of* 1797 *and* 1798, *as have been referred to the Meridians of Black Down, Butterton Hill, and St. Agnes Beacon.*

Meridian of Black Down.

Names of the Objects.	Latitude.	Longitude from Black Down.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Walton Windmill	51 6 59.5	0 13 22,1 W	2 45 44,5	11 2,9
Westonzoyland Steeple	51 6 33,8	0 12 12,9 W	2 44 35,3	10 58,3
Middlezoy Steeple	51 5 38,3	0 20 38,8 W	2 53 1,2	11 32,1
Chedzoy Steeple	51 8 5,1	0 23 33,7 W	2 55 56,1	11 43,7
Higham Windmill	51 4 21,8	0 15 18,6 W	2 47 41,0	11 10,7
Higham Steeple	51 4 34,6	0 16 18,5 W	2 48 40,9	11 14,7
Bridgewater Spire	51 7 40,7	0 27 16,3 W	2 59 38,7	11 58,6
Somerton Steeple	51 3 17,3	0 10 42,7 W	2 43 5,1	10 52,3
Burton Pynsent Obelisk	51 1 21,6	0 20 22,7 W	2 52 45,1	11 31
Westleigh Steeple	51 30 49,4	0 6 12,0 E	2 26 10,4	9 44,7
Bristol Cathedral	51 27 6,3	0 3 6,2 W	2 35 28,6	10 21,9
Redcliff Steeple	51 26 54,8	0 2 28,0 W	2 34 50,4	10 19,3
Long Aston	51 26 9,1	0 5 41,3 W	2 38 3,7	10 32,2
Clifden Windmill	51 25 57,2	0 5 3,3 W	2 37 25,7	10 29,7
Blaze Castle	51 30 10,4	0 5 19,3 W	2 37 41,7	10 30,8
Penpole Gazebo	51 29 33,7	0 7 31,7 W	2 39 54,1	10 39,6
Duke of Beaufort's House, Stoke	51 29 34,5	0 0 10,2 E	2 32 12,2	10 8,8
Durham Steeple	51 28 44,8	0 9 59,0 E	2 22 23,4	9 29,5
Knowle Steeple	51 32 53,7	0 2 7,9 W	2 34 30,3	10 18
Mangotsfield Steeple	51 29 9,5	0 3 39,2 E	2 28 43,2	9 54,8
Winterbown Steeple	51 31 36,4	0 1 51,2 E	2 30 31,2	10 2,1
Harfield Steeple	51 29 15,3	0 24 32,2 W	2 56 54,6	11 47,6
Leigh Steeple on Mendip	51 13 24,	0 5 36,3 E	2 26 46,1	9 47,1
Dundry Steeple	51 23 47,7	0 5 58,8 W	2 38 21,2	10 33,4

Names of the Objects.	Latitude.	Longitude from Black Down.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Doulting Spire	51 11 11,4	0 2 29,3 E	2 29 53,1	9 59,5
Devizes Steeple	51 21 25,5	0 33 51,2 E	2 58 31,2	11 54,1
Frome Steeple	51 13 47,9	0 13 40,8 E	2 18 41,6	9 14,7
Cold Aston	51 26 53,9	0 11 38,0 E	2 20 44,4	9 24,9
Puckle Steeple	51 29 16,2	0 6 49,6 E	2 25 32,8	9 42,2

Meridian of Butterton Hill.

Names of Objects.	Latitude.	Longitude from Butterton Hill.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Hope's Nose, Torbay	50 27 48,5	0 26 4,4 E	3 26 43,1	13 46,9
Werrington Steeple	50 39 52,2	0 28 19,4 W	4 21 6,9	17 24,4
Boyton Steeple	50 42 14,9	0 29 6,1 W	4 21 53,6	17 27,5
North Petherwin	50 40 52,5	0 32 15,3 W	4 25 2,8	17 40,2
St. Stephen's Steeple	50 38 50,3	0 28 32,6 W	4 21 20,1	17 25,3
Stokeclimsland Steeple	50 32 55,8	0 24 47,5 W	4 17 35,0	17 10,3
Launceston Steeple	50 38 18,1	0 27 54,1 W	4 20 41,6	17 22,7
Launceston Castle	50 38 16,8	0 27 57,9 W	4 20 45,4	17 23

Meridian of St. Agnes Beacon.

Names of Objects.	Latitude.	Longitude from St. Agnes Beacon.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
St. Minvern Steeple	50 33 30,6	0 20 28,1 E	4 51 27,6	19 25,8
St. Minvern Windmill	50 31 55,5	0 23 23,5 E	4 48 32,2	19 14,1
St. Isey Steeple	50 30 36,0	0 17 36,6 E	4 54 20,1	19 37,3
St. Merian Steeple	50 31 59,3	0 13 23,8 E	4 58 31,9	19 54,1

ART. XXXVI. *Latitudes and Longitudes of such Places, in the Series of* 1799, *as have been referred to the Meridians of Dunnose and Greenwich.*

Meridian of Dunnose.

Names of Objects.	Latitude.	Longitude from Dunnose.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Warwick Steeple	52 16 53,0	0 23 18,3 W	1 34 54,3	6 19,6
St. Martin's Spire, Coventry	52 24 25,4	0 18 29,5 W	1 30 5,5	6 0,3
Soleyhull Spire	52 2 30,4	0 34 13,8 W	1 45 49,3	9 3,3
Dunchurch Windmill	52 20 4,6	0 5 32,5 W	1 17 8,5	5 8,6

Names of Objects.	Latitude.	Longitude from Dunnose.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	° ′ ″	m. s.
Gazebo, Bardon Hill*	52 42 47,6	0 7 12,2 W	1 18 48,2	5 15,2
Markfield Windmill	52 41 16,8	0 5 1,0 W	1 16 37,0	5 6,5
Breadon Hill Building†	52 3 16,7	0 49 59,7 W	2 1 35,7	8 6,4
Newnham Windmill	52 13 55,7	0 0 36,2 E	1 10 59,8	4 43,9
Deddington Steeple	51 59 13,9	0 7 36,1 W	1 19 12,1	5 16,8
Bloxham Spire	52 1 5,6	0 10 29,7 W	1 22 5,7	5 28,4
Aynoe Steeple	51 59 35,2	0 3 10,2 W	1 14 46,2	4 59,1
Adderbury Spire	52 0 51,6	0 6 3,7 W	1 17 39,7	5 10,6
Farthingo Steeple	51 59 45,1	0 1 42,4 W	1 13 18,4	4 53,2
Round House, Edge Hills	52 7 25,6	0 15 18,4 W	1 26 54,4	5 47,6
Round House Windmill	52 7 11,4	0 15 32,6 W	1 27 8,6	5 48,6
Wingrove Steeple	51 51 46,8	0 27 28,7 E	0 44 7,3	2 56,5
Hardwick Steeple	51 51 47,8	0 22 2,6 E	0 49 33,4	3 18,2
Luggersal Steeple, Bucks	51 50 57,3	0 9 17,2 E	1 2 18,8	4 9,2
Granborough Steeple	51 55 4,3	0 18 45,2 E	0 52 50,8	3 31,4
Bicester Steeple	51 53 46,8	0 1 48,9 E	1 9 47,1	4 39,1
Abingdon Spire	51 40 3,8	0 5 1,2 W	1 16 37,2	5 6,5
Wallingford Steeple	51 36 2,4	0 4 36,2 E	1 6 59,8	4 27,9
Great Coxwell Windmill	51 38 59,8	0 25 32,4 W	1 37 8,4	6 28,5
Drayton Steeple	51 38 35	0 6 30,1 W	1 18 6,1	5 12,4
Highworth Steeple	51 37 51,4	0 30 38,1 W	1 42 14,1	6 48,9
Witney Spire	51 46 49,9	0 17 6,9 W	1 28 42,9	5 54,8
Bampton Steeple	51 44 11,2	0 20 51,9 W	1 32 27,9	6 9,8
Radley Steeple	51 40 58,3	0 31 57,4 W	1 43 33,4	6 54,2
Buckland Steeple	51 40 53,3	0 18 21,1 W	1 29 57,1	5 59,8
Witchwood Beacon	51 50 9,8	0 20 21,6 W	1 31 57,6	6 7,8
Stow on the Wold	51 55 46,9	0 31 23,6 W	1 42 59,6	6 51,9
Sarsden Chapel	51 54 16,4	0 22 49,9 W	1 34 25,9	6 17,7
Bourton Chapel	51 59 22,5	0 33 20,7 W	1 44 56,7	6 59,8
Walford Spire	52 0 31,6	0 26 12,5 W	1 37 48,5	6 31,2
Islip Steeple	51 49 20,7	0 2 21,9 W	1 13 57,9	4 55,8
Woodstock Steeple	51 50 47,4	0 9 24,5 W	1 21 0	5 24
Kidlington Spire	51 49 44,6	0 4 51,9 W	1 16 27,9	5 5,8

Meridian of Greenwich.

Names of Objects.	Latitude.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	m. s.
Pitchcot Windmill	51 52 58,5	0 50 35,5	3 22,3
Ivinghoe Spire	51 50 9,1	0 37 51,3	2 31,4
Quainton Steeple	51 52 28,7	0 54 28,0	3 37,8
Southern Obelisk, Stow Park	52 2 2,2	1 0 27,1	4 1,8
Northern Obelisk, ditto	50 2 30,2	1 0 42,9	4 2,8

* In page 658, this is, by mistake, called Breadon Hill Summer House.

† In page 659, this building is called Gazebo.

Names of Objects.	Latitude.	Longitude west of Greenwich. In degrees.	In time.
	° ′ ″	° ′ ″	m. s.
Leighton Buzzard Spire	51 54 56,5	0 39 54,4	2 39,6
Aylesbury Spire	51 49 18,9	0 50 18	3 21,2
Hanslope Spire	52 6 45,2	0 49 17,8	3 17,2
North Crawley Spire	52 5 31,1	0 38 38,4	2 34,5
Pavenham Spire	52 11 36,3	0 32 27,0	2 9,8
St. Paul's Spire, Bedford	52 8 8,8	0 27 43,3	1 50,9
Sharnbrook Spire	52 12 55,1	0 32 48,0	2 11,2
Woburn Market-House	51 59 17,4	0 36 58,5	2 27,9
Woburn Steeple	51 59 21,8	0 37 0,3	2 28
Ridgemont Station	52 0 56,4	0 34 45,7	2 19
Wootton Steeple	52 5 39,2	0 31 55,7	2 7,7
Cranfield Spire	52 4 3,1	0 36 11,1	2 24,7
Husborne Crawley Steeple	52 0 57,0	0 36 19,8	2 25,3
Souldrope Spire	52 14 38,6	0 33 9,1	2 12,6
Windmill near Tharfield	52 1 30,9	0 3 20,4	0 13,3
Tottenhoe Station	51 53 18,9	0 34 37,5	2 18,5
Chalgrave Steeple	51 53 40,2	0 30 51,4	2 3,4
Keysoe Spire	52 14 58,5	0 25 24,3	1 41,6
Moulshoe Steeple	52 2 59,0	0 40 39,6	2 42,6
Renhold Spire	52 9 41,5	0 24 20,1	1 37,3
Lidlington Windmill	52 2 4,2	0 33 25,0	2 13,7
Maulden Steeple	52 1 52,2	0 27 20,2	1 49,3
Harlington Steeple	51 57 48,4	0 29 18,6	1 57,2
Millbrook Steeple	52 1 43,6	0 31 15,5	2 5
Stretley Steeple	51 56 42,8	0 26 12,4	1 44,8
Sauldon Windmill	51 57 9,7	0 47 26,9	3 9,8
Knotting-Green Elm Tree	52 15 26,6	0 31 11,5	2 4,7
Ravensden Steeple	52 10 33,9	0 25 15,7	1 41
Bow Brickhill Steeple	52 0 1,1	0 40 13,4	2 40,9
Colmworth Spire	52 12 49,3	0 22 27,0	1 28,5
Sundon Windmill	51 57 52,2	0 28 57,0	1 55,8
Silsoe Steeple	52 0 33,0	0 25 21,4	1 41,4
Flitton Steeple	52 0 48,1	0 27 14,4	1 48,9
Shillington Steeple	51 59 31,7	0 21 45,0	1 27
Westoning Steeple	51 59 2,7	0 30 5,9	2 0,4
Wrest-Garden Obelisk	52 0 16,2	0 25 10,7	1 40,7
Flitwick Steeple	51 59 58,6	0 30 27,1	2 1,8
Ampthill Steeple	52 1 57,8	0 29 11,7	1 56,7
St. Neot's Steeple	52 13 34,7	0 15 49,9	1 3,3
Pollux Hill Steeple	51 59 31,2	0 27 8,7	1 48,6

ART. XXXVII. *Latitudes and Longitudes of some remarkable Places, not contained in the preceding Tables.*

St. Nicholas's or Drake's Island, in Plymouth Sound.

The bearing of Kit Hill, from the meridian of Butterton, is 67° 12′ 12″, and the angle between it and the flagstaff on Drake's Island, 41° 40′ 8″; therefore, the bearing of the latter from the meridian is 71° 7′ 40″; consequently, its distance from the meridian is 60531 feet, and from the perpendicular 20692 feet, which respectively subtend 9′ 53″6, and 3′ 24″,5. These, with the latitude and longitude of Butterton, 50° 24′ 46″,8 and 3° 52′ 47″,5, give 50° 21′ 21″,1 for the latitude, and 4° 8′ 17″,9 for the longitude, of the flagstaff on Drake's Island.

The latitude and longitude of this spot was determined by Mr. BAYLEY, in the year 1792. The observations for the former were as follows:

50° 21′ 20″	☉'s LL.
50 21 30,5	ditto.
50 21 31	ditto.
50 21 29	α Aquilæ.
50 21 26,5	α Ophiuchi.
50 21 55	☉'s LL.

The mean of these is 50° 21′ 28″,5.

The place chosen by Mr. BAYLEY, as I have been lately informed, was a few feet northward of the staff; therefore, 7″,4 may be taken for the true difference between our determinations.

The longitude of Mr. BAYLEY's station, found by the *moon's transit*, was 4° 18′ 52″; but the longitude deduced from the recent operations, is 4° 8′ 17″,9; there is, therefore, a difference of 10′ 34″,1 between the two determinations.

St. Andrew's or the Old Church, at Plymouth.

The angle at Butterton, between the Old Church tower and Kit Hill, is 37° 45′ 5″,2; its bearing, therefore, south-west from the meridian, is 75° 1′ 56″; consequently, its distance from the meridian is 57505 feet, and from the perpendicular 15374 feet. These respectively subtend 9′ 24″, and 2′ 32″,1: hence, its latitude becomes 50° 22′ 13″,6, and longitude 4° 7′ 31″,6 = 16^{m} 30^{s},1 in time, west of Greenwich.

As it is of very great importance that the truths of the conclusions given in this Work should receive support, wherever I can find it, I think it right to mention the result of his Excellency the Count de BRUHL's endeavours to ascertain the longitude of Plymouth, by means of chronometers. The following is a copy of his communication, made in the year 1795.

Journey from Plymouth to London.

Green Timekeeper.

June 8th, 1783.	Mr. MUDGE's clock* at Plymouth, fast for mean time	0^{m}	32^{s},15
	Timekeeper faster than Mr. MUDGE's clock	0	25 ,6
14th.	Timekeeper slower than London clock	14	29 ,4
	London clock slow for mean time	0	36 ,5
	Difference of longitude	16	3 ,65

Blue Timekeeper.

June 8th,	Mr. MUDGE's clock at Plymouth, fast for mean time	0^{m}	32^{s},15
	Timekeeper faster than Mr. MUDGE's clock	0	37 ,4
14th.	Timekeeper slower than London clock	14	17 ,2
	London clock slow for mean time	0	36 ,5
	Difference of longitude	16	3 ,25
	Mean difference	16	3 ,55

The longitude of St. Paul's, west of Greenwich, is 23^{s},1 in

* It is, perhaps, right to observe, that Mr. T. MUDGE's transit, at Plymouth, was made by the late Mr. BIRD, and properly set up between stone pillars. The clock, the entire work of his own hands, was a most excellent one.

time; and Mr. DUTTON's house in Fleet-street is about 2ˢ west of St. Paul's;* wherefore, its longitude west of Greenwich is 25ˢ: consequently, $16^m\ 3^s{,}55 + 25^s = 16^m\ 28^s{,}55$, is the difference of longitude between Greenwich and Plymouth, as shewn by the timekeepers.

Now the meridian of Mr. MUDGE's transit-room, at Plymouth, passed only 35 feet to the eastward of the centre of St. Andrew's Tower, his northern meridian mark being on the church itself; therefore, the longitude of the church and transit-room may be considered the same. From the survey, we find it to be $16^m\ 30^s{,}1$; and, from Count BRUHL's determination, making a just allowance for the difference of longitude between the late Mr. DUTTON's house and Greenwich, $16^m\ 28^s{,}5$.

It is left for the public, and this learned Society in particular, to determine how far the near agreement of these several methods, tends to corroborate the assertion I have advanced, of the dependence which may be placed on the deductions drawn from the observations made at Beachy Head and Dunnose. If there had been only one watch employed on the occasion, the result would not have been so satisfactory as the circumstance of two being used seems to make it. As the occasion calls for the remark, before I dismiss this article, I must observe, that the highest advantages would accrue to geography, were the ideas of the Astronomer Royal carried into execution, (and which I shall endeavour to do at some future period,) respecting the discovery of the difference of longitude between Greenwich and some very remote point on the western side of the island, (St. David's Head for instance,) by means of timekeepers,

* According to HORWOOD's Map of London, the distance from the centre of St. Paul's to Bolt Court, at the corner of which Mr. DUTTON's house is situated, is 31 chains.

carried backwards and forwards in the mail coaches. If this excellent scheme were executed, and the watches employed equal to the best now made, it is probable that the true difference of longitude would shortly be determined. The geodetical situation of St. David's Head will, ere long, be ascertained from a prosecution of the survey: a knowledge, therefore, of its true longitude would be attended with eminent advantages.

Lizard Light-Houses.

The light-houses on this head-land were observed from Pertinney and Karnbonellis. At the latter, Pertinney bears 74° 22′ 41″ south-west, from the parallel to the meridian of St. Agnes; and, as the angle between the western light-house and Pertinney is 78° 40′ 5″, it follows, that the bearing of the light-house from the said parallel is 4° 17′ 24″ south-east. Computing with this angle and the distance from Karnbonellis to the light-house, we get 3844 feet, and 126499 feet, for the distances of that object from the meridian and perpendicular of St. Agnes: therefore, admitting the length of the degree in the meridian, in the middle point between St. Agnes and the light-house, to be 60850 fathoms, and 61182 for the length of a degree of a great circle perpendicular to it, we get 20′ 47″,4, and 32″,8, for the small arcs which those spaces respectively subtend. These *data*, with the latitude and longitude of St. Agnes, 50° 18′ 27″, and 5° 11′ 55″,7, give the latitude of the light-house = 49° 57′ 44″, and longitude west of Greenwich 5° 11′ 4″,8, in time, 20ᵐ 44ˢ,3.

This light-house was also observed from the station on Karnminnis. The triangle resulting from that observation, together with the angle at Karnbonellis, is

Karnminnis - 44° 9′ 46″
Karnbonellis - - 98 1 30

Western Light-house 37 48 44; which gives 81342 feet, for the distance between the station Karnbonellis and the Light-house. This distance is said, in the Philosophical Transactions for 1797, p. 501, to be 81348 feet, which differs only 6 feet from the above determination; but it is probable the distance first given is most correct, as the two light-houses appearing nearly in the same line at Karnminnis, was the means of preventing us from clearly distinguishing the apex of either, and it was principally on this account that we preferred the observation made at Pertinney. The agreement however proves, hat no inconsistency can be found to obtain with respect to the *data* before given, for settling the situation of this important headland.

In the Philosophical Transactions for 1797, page 502, it is mentioned, that the distance from the spot where the late Mr. BRADLEY made his observations, to the place where his meridian mark was fixed, was 800 feet. But there appears to be some inconsistency in this particular; as Mr. BRADLEY's own words, in an extract of a letter now before me, are, *it was just* 480 *feet.* Adding to this, 24 feet, the distance between the place of the meridian mark and the line joining the centre of the light-houses, we get the distance of the point O, or the place of the Observatory, (see Phil. Trans. 1797, p. 502,) from the line joining the light-houses W, E, = 504 feet; a space corresponding to 5″ of latitude, nearly; therefore, from the trigonometrical operations, we get,

and $\left.\begin{matrix} 49^{\circ}\ 57'\ 44'' \\ 5\ 11\ 4,8 \end{matrix}\right\}$ $\begin{matrix} \text{for the latitude} \\ \text{for the longitude} \end{matrix}$ of Mr. BRADLEY's station.

Mr. BRADLEY's observations for finding the latitude, were made with a quadrant of one foot radius, the workmanship of Mr. BIRD; they were as follows.

Nine meridional altitudes of the sun's limb, the extreme results of which were 49° 57′ 27″,5 and 49° 57′ 44″, gave for the latitude of the Observatory - - - -	49° 57′ 35″
Six meridional observations of the Pole Star below the Pole, the extreme results of which were 49° 57′ 35″ and 49° 57′ 20″,4, gave for the latitude - - - -	49 57 23,2
Thirteen observations of Arcturus, α Coronæ Borealis, and α Serpentis, the extreme results of which were 49° 57′ 54″,7 and 49° 57′ 2″,7, gave for the latitude - - -	49 57 29
Fifteen observations of α, β, γ Draconis, the extreme results of which were 49° 57′ 22″,2 and 49° 57′ 2″,7, gave for the latitude - -	49 57 33
The mean of which is -	49 57 30

According to the trigonometrical operations, the latitude is 49° 57′ 44″; there is, therefore, a difference of 14″ between the results; a quantity so large as justly to excite surprise, if it were not generally understood, that much dependance cannot be placed on observations made with an astronomical quadrant precisely similar to that made use of by Mr. BRADLEY. The *extreme* results in the above, differ so widely as to authorise the truth of the supposition on this occasion.

The longitude of the Lizard was determined by the transit of Venus, Sun's eclipse, transit of the Moon, and two emersions

of Jupiter's first satellite, as particularly set forth in the Preface to the Nautical Ephemeris of 1791. The conclusions were as follows.

Four transits of the Moon, calculated by Mr. WALES, gave for the longitude			20ᵐ 30',6
Two emersions of Jupiter's first satellite, calculated by ditto			21 14 ,5
Transit of Venus, calculated by	Doctor MASKELYNE		20 57 ,0
	Mr. WITCHELL		20 56 ,5
	Mr. WALES		20 57 ,0
Sun's eclipse, calculated by	Mr. WITCHELL		20 44 ,5
	Mr. SEJOUR		20 45 ,1
	Mr. EULER		20 59 ,0
	Mr. LEXEL		20 51 ,0
	Mean of the whole		20 52 ,12

From the trigonometrical operations, we find the longitude in time to be 20ᵐ 44',3; there is, therefore, a difference of 7',82 between these different determinations: this is, probably, as near as we could have expected to find it; yet it can scarcely be supposed, that of this difference, more than 2' can be laid to the account of the survey.

In the Philosophical Transactions for 1797, p. 502, it is observed, that angles were taken at the Lizard Light-house and Naval Signal-Staff, to determine the situation of the *Point* itself. This Point, marked P in the diagram, makes an angle of 2° 28' 16" S W, with the parallel to the meridian of St. Agnes at the station on Karnbonellis, and is therefore 636,6 feet from that meridian, and 126394 feet from the perpendicular; therefore 49° 57' 40",6 is the latitude } of the Lizard Point.
and 5 11 46 the longitude }

Scilly Islands.

To determine the distances of the objects in these islands, from the stations near the Land's End, with sufficient accuracy, proper corrections were made for reducing the horizontal angles to those formed by the chords. On the present occasion, it will be right to use the horizontal, and not the chord angles; the distances from the meridians, and from their perpendiculars, being computed on the supposition of the earth's surface being a plane, which, within the limits of our fixed meridians, may be considered as true.

The angles for finding the distances of these objects are given in the Philosophical Transactions for 1797, p. 503; from whence, and the *data* contained in this Work, we get the bearing of

the *Day-mark* in the Island of St. Martin's from	St. Buryan	75°	44′	52″	S W
	Pertinney	71	14	22	S W
	Sennen	75	30	9	S W

which, combined with the distances of the stations from the meridian of St. Agnes, give

246801
246804
246821
} feet, for the distance of the Day-mark from the meridian of St. Agnes;

and 122409
122410
122414
} feet, for the distance of it from the perpendicular.

The mean of the first is 246809 feet, and the mean of the last 122411 feet; but the latter becomes 122419, because a line drawn from the Day-mark, perpendicular to the meridian of St. Agnes, cuts that meridian eight feet *below* the parallel.

Again, we get the bearing of

the Windmill and the Flagstaff of the Fort of Mary, from	in the Island of St. Pertinney	65°	32′	30″	S W
	Pertinney	66	53	5	S W

from whence, after a similar correction with that just made, we find the distance of

the Windmill 256304 } feet from the
the Flagstaff 260152 } meridian, and
{ 143597 } feet from the perpendicular of
{ 140876 } St. Agnes.

From the same page, and the *data* furnished in this work, we also find the bearing of

St. Agnes Light-House from { Sennen - 68° 6′ 54″ S W
{ St. Buryan 69 5 56 S W; which gives

265865 } feet, for the distance from the meridian, and
265879 }

149121 } feet, for the distance from the perpendicular of St. Agnes.
149128 }

The mean of the first is 265872 feet, and the mean of the last, when corrected, 149133 feet.

With the above data, and also the latitude and longitude of St. Agnes, we get

the latitude of	Day-mark in St. Martin's		49° 58′ 2″,9
	Windmill, St. Mary's	-	49 54 32,7
	Flagstaff, ditto	-	49 54 59,1
	St. Agnes Light-House*	-	49 53 36,8

				In Time.
and longitude west from St. Agnes.	Day-mark	1° 2′ 43″,1	from the meridian of Greenwich. -	6° 14′ 38″,8 24ᵐ 58ˢ,6
	Windmill	1 5 3,2		6 16 58,7 25 7 ,9
	Flagstaff	1 6 2,7		6 17 57,4 25 11 ,9
	Light House	1 7 27,7		6 19 23,4 25 21 ,5

* In the *Requisite Tables*, published by order of the Board of Longitude, the latitude of the Scilly Lights is said to be 49° 56′ 0″, and longitude 6° 46′ 0″. The latitude, according to the survey, is 49° 53′ 36″,8, and longitude 6° 19′ 23″,4. An error of 2′ 23″ in the latitude, may not perhaps be considered extraordinary; but how, in a maritime country, like our own, where chronometers are in such constant use, so great an error as 26′ 37″ (1ᵐ 46ˢ,½ in time) in the longitude, should have remained undetected, excepting by one person, is surprising. J. HUDDART, Esq. visited the Scilly Isles, having with him a watch made by ARNOLD, and obtained his time at that spot in the island of St. Mary where the body of Sir CLOUDSLEY SHOVEL is said to have been thrown ashore, by means of equal altitudes of the Sun's limb; he then found, comparing his time with that shewn by the watch, that 0ʰ 25ᵐ 18ˢ was the difference between the meridians of Greenwich and this spot in St. Mary's. Now St. Agnes Light-house is about 2′ of a degree west of the place to which Mr. HUDDART alludes; therefore, 25′ 18″ + 8″ = 25′ 26″ is the longitude of St. Agnes, through these means; which differs only 4″,5 in time from that found by the survey.

The Observatory of his Grace the Duke of MARLBOROUGH, *at Blenheim.*

The staff erected over the quadrant, was observed from White Horse Hill and Whiteham Hill. At the former station, the latter makes an angle of 36° 30′ 13″,5, with the parallel to the meridian of *Dunnose*. The staff, therefore, bears from the parallel 25° 59′ 29″,75 NE.; consequently, its distance from the meridian of Dunnose is 36540 feet, and from the perpendicular 446458 feet. These respectively subtend 5′ 58″,3, and 1° 13′ 21″,4; therefore, the latitude of the Observatory is 51° 50′ 28″,3, and its longitude 9′ 39″,9 from Dunnose: but 1° 11′ 36″ is the longitude of that station; therefore, 1° 21′ 15″,9, or 5′ 25″,2 in time, is the longitude of the Observatory west from Greenwich.

As the meridian of Dunnose passes at no great distance from that of Blenheim, I have deduced the latitude and longitude from the former, to avoid the errors which creep in, when computations are carried on from remote meridians. It may be worth while, however, to show that the extent of those errors would not be great, were the meridian of Dunnose neglected, and the Observatory at Blenheim referred to the meridian of Greenwich.

The distance of White Horse Hill from the meridian of Greenwich is found to be 356050 feet, and from its perpendicular 39425 feet; the bearing of Nuffield, from the parallel at that station, being 89° 59′ 27″ SE. Blenheim will, therefore, be found to bear 26° 55′ 25″ NE from the parallel at White Horse Hill; consequently, its distance from the meridian of Greenwich is 307224 feet, and from its perpendicular 135569 feet. These give the arcs 50′ 12″,4, and 22′ 16″,1; from whence we get 51° 50′ 28″,1 for the latitude, and 1° 21′ 16″ for the longitude,

of the Observatory west of Greenwich. Either of these determinations may be taken for the true result, but I shall prefer the first.

Being favoured by his Grace with the latitude and longitude derived from astronomical observations, we have the following comparisons:

					Degrees.	Time.
Latitude	observed	51° 50′ 24″,9	Longitude west from Greenwich.		1° 21′ 6″,0	5ᵐ 24ˢ,4
	computed	51 50 28 ,1			1 21 15 ,9	5 25 ,1

Observatory at Oxford.

The angle at the station on Shotover, between the Atlas on the top of the Observatory and the parallel to the meridian of Dunnose, is 79° 50′ 51″,75 N W: therefore, its distance from the meridian is 14719 feet, and from the perpendicular 416985 feet. The figure representing Atlas is 33 ¾ feet *due east* of the Quadrant Room; consequently, no correction will be required in the computed latitude. The space 14719 feet subtends an arc = 2′ 24″,3, and 416985 feet an arc of 1° 8′ 30″,8. These *data*, with the latitude and longitude of Dunnose, give 51° 45′ 38″ for the latitude, and 1° 15′ 29″,2 for the longitude, of the Observatory. As in the former case, with respect to Blenheim, so in the present instance, it is immaterial whether the calculations be carried on from the meridian of Greenwich or that of Dunnose, as differences of only 0″,1 in both the latitude and longitude are found in the results.

The latitude and longitude of this Observatory are given in the *Requisite Tables*; the first is 51° 45′ 38″, and the last 1ᵐ 15′ 30″, or 5ᵐ 2ˢ in time. Doctor Hornsby, however, has furnished me with what he conceives to be more accurate

determinations; from which, and the above, we have the following comparisons:

			Degrees.	Time.
Latitude observed	51° 45′ 39″,5	Longitude west from Greenwich. observed	1° 15′ 22″,5	5m 1″,5
Latitude computed	51 45 38 ,0	Longitude west from Greenwich. computed	1 15 29 ,2	5 1 ,9

I conclude this article with expressing an opinion, that the coincidence between the computed and, no doubt, accurately observed longitude of this Observatory, affords strong reason for supposing, that the operations at Beachy Head and Dunnose, in 1794, for finding the length of a degree of a great circle perpendicular to the meridian on the earth's surface, were made with the required accuracy.

SECTION THIRD.

Trigonometrical Surveys of the Northern and Western Parts of Kent, the County of Essex, and Parts of the adjoining Counties, Suffolk and Hertford, executed in the Years 1798 *and* 1799. *(See Plate* XXXII.*)*

It will be convenient to treat of the operations carried on in the north of Kent and Essex, before we speak of those executed in the western parts of the former county.

In a former article I have observed, that from the old station at Wrotham, (General Roy's,) the view towards the north is obstructed, and also that it became necessary to select a new one: this station was found to be 205,5 feet from the other; the distance was accurately measured, and afterwards the angle taken at the *old* station, between the staff on Severndroog Tower,

Shooters Hill, and the one newly chosen; this angle subtended 94° 19′ 0″,5.

The distance from Severndroog Tower to the old station at Wrotham, is 79960 feet. But, it must be observed, this distance is not precisely the same as that given by General Roy, because an allowance is made for the error in the reduction of the bases, in the surveys of 1787 and 1788.

With the distances 79960 feet and 205,5 feet, and the included angle, 94° 19′ 0″,5, we find the distance of the Flag-staff on Severndroog Tower, from the new station = 79944 feet; with this distance, a part of the following triangles have their sides computed.

ART. XXXVIII. *Principal Triangles.*

Names of stations.	Observed angles.	Distances of the stations.	Feet.
Wrotham Gravesend *Severndroog Tower*	° ′ ″ 62 54 38 82 39 21	Gravesend	45578 71762
Gravesend Langdon Hill *Severndroog Tower*	95 53 59 53 47 25	Langdon Hill	44886 88470
Gravesend Hadleigh Steeple *Langdon Hill*	34 31 53 45 11 51	Hadleigh Steeple	64076 37171
Gravesend Hadleigh Halstow	30 24 19—21 41 46 32—33 107 49 5— 6 179 59 57	Halstow Steeple	44839 34064
Gravesend Halstow *Gadshill*	31 38 21 24 18 21	Gadshill	22277 28390
Halstow Hadleigh Steeple Sheppey Isle	59 18 6—5 49 13 33½—32 31 28 24—23 180 0 3,5	Sheppey	49409 64387

The distances of Gadshill from Halstow, and from Halstow to the Isle of Sheppey, in the following triangle, viz.

Halstow	128	34	28
Sheppey	18	18	3
Gadshill			

give the distances between Gadshill and the station in the Isle of Sheppey 70687 and 70685 feet: the mean, 70686 feet, may be taken for the true distance.

Names of stations.	Observed angles.	Distances.
	° ′ ″	
Hadleigh - -	38 43 29	Southend - - - { 27596
Southend - -	119 20 5	{ 46204
Sheppey		

To find the distance between Langdon Hill and the spindle of the weather-cock on Rayleigh Steeple, we have the following quadrilateral.

Langdon Hill	122°	2′	46″
Gravesend -	64	56	14
Halstow -	131	20	14
Rayleigh -	61	40	46
	360	0	0,

which gives the distance from the centre of Rayleigh Steeple to the staff on Langdon Hill = 44131 feet; but the point on the top of Rayleigh Tower, over which the instrument was placed, was just 7 feet farther from Langdon Hill than the spindle; therefore, 44131 + 7 = 44138 feet, is the distance between Langdon Hill and the station on the steeple.—The angles in the following triangles,

Hadleigh -	134°	11′	55″
Sheppey -	16	26	30
Langdon Hill			
Langdon Hill	49	8	5
Sheppey -	27	4	46
Rayleigh			

give the distance of the *Spindle* on Rayleigh Tower from { Langdon Hill = 44131 / Hadleigh = 15554 } Feet.

From the preceding quadrilateral, the distance between the spindle on Rayleigh Tower and the station on Langdon Hill, was found = 44131 feet, which is the same as the other determination.

Names of stations.	Observed angles.	Distances.	
	° ′ ″		Feet.
Halstow	95 46 57	Spindle	49413
Sheppey	42 6 39		73313
Rayleigh Tower Spindle			
Halstow	35 1 8	Prittlewell	46830
Hadleigh	99 3 3		27206
Prittlewell Steeple			
Halstow	64 16 58	Prittlewell	46823
Sheppey	55 24 34		51243
Prittlewell			
Halstow	73 45 42	Canewden	71211
Sheppey	66 39 49		74461
Canewden Steeple			
Rayleigh	53 5 0	Canewden	31438
Prittlewell	73 41 30		26189
Canewden			
Hadleigh	52 52 24	Flagstaff	51846
Halstow	86 10 13		34060
Flagstaff of the Garrison, Sheerness			
Severndroog Tower	17 48 23	Purfleet Cliff	40423
Gravesend	20 22 40		35498
Purfleet Cliff	141 48 57		
	180 0 0		
Rayleigh	97 7 27	Danbury	47514
Langdon Hill	43 18 2		68746
Danbury Spire			
Severndroog Tower	26 24 33	Frierning	103659
Langdon Hill	95 25 0		46312
Frierning Steeple	58 10 27		
Langdon Hill	88 14 19	Frierning	46314
Frierning	44 13 19		63270
Rayleigh			

Mean distance from Langdon Hill to Frierning Steeple 46313 feet.

Names of Stations.	Observed angles.	Distances.	Feet.
Frierning Langdon Hill *Danbury Steeple*	° ′ ″ 92 15 6 45 26 17	Danbury	49020 68748
Langdon Hill Rayleigh *Signal Staff, Shoebury-ness*	24 27 23 132 52 23	Signal Staff	83902 47408
Triptree, old station Rayleigh *Frierning*	47 8 50 73 45 24		
Triptree, old station, from		Rayleigh Tower Frierning	74052 82860
Triptree Danbury *Rayleigh*	31 59 21 124 20 48		
Danbury Spire from Triptree Heath			36000
Triptree, old station Tillingham Steeple *Danbury Spire*	100 28 19 30 14 40		
Tillingham from		Triptree Danbury	54172 70281
Tillingham Peldon *Danbury*	84 52 34 62 39 36	Peldon	42469 78803
Tillingham Peldon *Flagstaff on St. Osyth Priory*	48 58 50 83 42 46	Flagstaff	57433 43595
Peldon Thorp *Flagstaff, St. Osyth Priory*	20 49 10 32 47 18	Thorp	64802 28612
Peldon Thorp *Stoke Steeple*	74 46 5 52 6 31	Stoke	63931 78171
Peldon Great Tey *Danbury*	71 48 20 75 51 12	Great Tey	43475 77204

Names of the Stations.	Observed angles.	Distances.	
	° ′ ″		Feet.
Peldon	46 14 2	Stoke	63941*
Great Tey	90 56 9	Stoke	46182
Stoke			

From a former triangle, the distance between Peldon and Stoke Steeple was found to be 63931 feet; wherefore, 63936 feet, the mean, may be taken for the true distance.

Thorp	98 52 20	Little Bentley	20481
Little Bentley	53 2 30	Little Bentley	42981
Dover Court			
Thorp	41 12 53	Little Bentley	20481
Little Bentley	123 30 18	Little Bentley	51205
Peldon			
Tillingham	96 57 20	West Mersea	28924
Danbury Spire	61 46 57	West Mersea	79173
West Mersea			
Rayleigh	54 27 44	West Mersea	96701
West Mersea	29 13 0	West Mersea	79170
Danbury			
Great Tey	52 11 44		
Stoke	45 12 57		
Staircase, St. Mary's Steeple, Colchester			
	St. Mary's Steeple from Stoke		36796
Little Bromley	54 11 22	Little Bromley	44356
Stoke	47 58 26	Little Bromley	33706
St. Mary's, Colchester			
Dover Court	18 58 19	Tattingstone	38946
Stoke	14 53 50	Tattingstone	49250
Tattingstone			
Thorp	37 52 49	Tattingstone	50690
Stoke	39 12 4	Tattingstone	49245
Tattingstone			
Dover Court	50 26 54	Falkenham	31651
Rushmere	38 25 20	Falkenham	39270
Falkenham Steeple			

The distance from Dover Court Steeple to Stoke Steeple is 84425 feet, and from Rushmere Steeple to Stoke Steeple 75955 feet; the included angle at Dover Court Steeple is 62° 38′ 20″. These give the distance of Dover Court Steeple from Rushmere, 50921 feet.

Names of Stations.	Observed angles.			Distances.		
	°	′	″			Feet.
Dover Court	43	40	51	Tattingstone		38946
Rushmere	49	46	9	Tattingstone		35232
Tattingstone						
Dover Court	25	55	13	Woodbridge		59894
Rushmere	96	25	30	Woodbridge		26346*
Woodbridge Steeple	57	39	17			
	180	0	0			
Falkenham	41	25	50	Woodbridge		33761
Rushmere	58	0	10	Woodbridge		26342*
Woodbridge						
Falkenham	48	42	0	Butley		45013
Woodbridge	83	10	0	Butley		34058
Butley Steeple						
Falkenham	21	58	1	Orford Light House		60589
Butley	116	14	59	Orford Light House		25207
Orford Light House						
Rushmere	62	45	1–0	Otley		29238
Woodbridge	63	30	1–0	Otley		29044
Otley Steeple	53	45	0			
	180	0	2			
Rushmere	40	25	30	Henley		21211
Otley	46	25	0	Henley		18988
Henley Steeple	93	9	30			
	180	0	0			
Dover Court	12	43	40	Obelisk		26766
Rushmere	13	22	10	Obelisk		25503
Obelisk, Woolverstone Park						
Rushmere	61	35	58	Copdock		28984
Copdock Steeple	53	5	10	Copdock		28057
Obelisk						
Rushmere	85	25	0	Henley		21209
Copdock	37	46	0	Henley		34520
Henley	56	49	0			
	180	0	0			

Names of Stations.	Observed angles.	Distances.	Feet.
Henley	° ′ ″		
Copdock	58 32 42—40	Naughton	45518
Naughton Steeple	74 30 11—10		40294
	46 57 11—10		
Naughton	74 24 2	Lavenham	35867
Stoke	45 58 58		48039
Lavenham Steeple	59 37 0		
Lavenham	67 48 30	Bulmer	36837
Stoke	44 59 10		48248
Bulmer Steeple	67 12 20		
Lavenham	47 34 25	Glemsford	25746
Bulmer	44 18 40		27086
Glemsford Steeple			
Lavenham	18 22 0	Topplesfield	67962
Bulmer	142 15 20		34983
Topplesfield			
Lavenham	51 36 40	Twinestead	43349
Stoke	58 8 10		40006*
Twinestead Steeple			
Stoke	50 4 48	Twinestead	40006*
Great Tey	56 15 56		36895
Twinestead			
Frierning	156 42 10	Southweald	30138
Danbury	8 50 0		77622
Southweald Steeple			
Danbury	151 18 36	Gallywood	26097
Triptree, old Station	12 0 34		60211
Gallywood Common			
Triptree, old Station	37 41 44	Pleshley	63213
Gallywood	75 13 56		39973
Pleshley Steeple			
Danbury	55 31 11	Pleshley	48455
Gallywood	91 54 46		39964
Pleshley			
Gallywood	15 45 30	High Easter	47767
Pleshley	114 49 0		14293
High Easter Steeple			

Names of stations.	Observed angles.			Distances.		
	°	′	″			Feet.
Danbury - -	12	4	30	} Hatfield Broad Oak -	{	85096
Pleshley - - -	152	53	10		{	39058
Hatfield Broad Oak Steeple						
Danbury - -	25	45	6	} Thaxted - -	{	101330
High Easter - -	29	43	54		{	53429
Thaxted Spire						
Hatfield Broad Oak -	54	29	51	} Beauchamp Roding -	{	24853
Pleshley - - -	39	25	0		{	31806
Beauchamp Roding Spire						

The angle observed from the station on Danbury Steeple, between Hatfield Broad Oak and Thaxted, was 30° 33′ 40″; this, with the including sides, 85094 and 101330 feet, gives the following triangle:

Danbury	30°	33′	40″
Hatfield Broad Oak	92	24	0
Thaxted -	57	2	20, which gives the distance between Thaxted and Hatfield Broad Oak = 51566 feet.

Danbury - - -	27	24	19	} Stoke - -	{	122630
Peldon - - -	118	2	28		{	63951
Stoke						

Again, the angle observed at Danbury, between Thaxted and Stoke was 66° 43′ 8″; this, with the sides which form it, Danbury and Thaxted, Danbury and Stoke, gives the following triangle:

Danbury -	66°	43′	8″
Stoke - -	48	25	16
Thaxted -	64	51	36, from which we find 124430 feet, for the distance from Thaxted to Stoke.

The angle at Lavenham Steeple, between Stoke and Thaxted, was likewise observed, and found to be 89° 10′ 30″, which, with the distances of these latter stations from Lavenham, 48039 and 124430 feet, gives

Lavenham -	89°	10′	30″
Stoke - -	68	7	0
Thaxted -	22	42	30, from which we find 115480 feet to be the distance from Thaxted Spire to Lavenham Steeple.

The angle at Danbury, between Southweald and Hatfield Broad Oak, was found to be 54° 44′ 30″. The distances from Danbury to Southweald and Hatfield Broad Oak have been already found, the former being 77622 feet, and the latter 85096 feet; from these we get the triangle,

Danbury	-	54° 44′ 30″
Southweald	-	67 42 5
Hatfield Broad Oak		57 33 25,

which gives 75104 feet, for the distance between Hatfield Broad Oak and Southweald Steeples.

In order to connect the preceding triangles with those carried on for the survey of the south-western part of Essex, and of Hertfordshire, stations were selected on Hampstead Heath, and on Highbeech in Epping Forest, to which the great theodolite was taken, as related in the article detailing the particulars of the operations in 1799. The triangles making this connection are the following. The first, namely,

Severndroog Tower		28° 58′ 10″
Southweald	-	94 49 5
Langdon Hill	-	56 12 45,

is had from the included angle at Severndroog Tower, 28° 58′ 10″, and the sides Severndroog Tower and Southweald, Severndroog Tower and Langdon Hill: the first is 73787 feet, and the second 88479 feet. From these *data*, we obtain the distance between the station on Langdon Hill and that on Southweald Steeple = 43001 feet.

Names of Stations.	Observed angles.	Distances.	Feet.
Severndroog Tower -	° ′ ″		
Langdon Hill - -	24 24 35	Brentwood -	78553*
Brentwood Steeple	62 26 39		36616
Severndroog Tower -			
Southweald - -	4 33 29	Brentwood -	78553*
Brentwood	125 53 12		7706

Foot of the cross on the dome of St. Paul's from the station on Severndroog Tower 39962*. Phil. Trans. for 1787. p. 250.

Severndroog Tower -			
St. Paul's - -	33 53 4	Highbeech -	71534
Highbeech	51 24 12		61919
Severndroog Tower -			
Highbeech - -	44 34 28	Southweald -	73795*
Southweald	69 53 13		55156

From the last triangle, we find the distance from Severndroog Tower to the station on Southwald Steeple to be 73795 feet; this, it will be perceived, is deduced from the distance between the cross on the dome of St. Paul's and Severndroog Tower; but 73791 feet has been found by the triangle, which is derived from the distance between the latter station and Wrotham. A difference of 4 feet on such a distance, all things considered, is not a large quantity.

Names of Stations.	Observed Angles.			Distances.		Feet.
	°	′	″			
Severndroog Tower -	49	8	11	Brentwood -	{	78558
Highbeech - -	74	16	44		{	62727
Brentwood Spire						
Severndroog Tower -	31	24	12	Hampstead Heath	{	64855
Highbeech - -	58	29	19		{	39455
Hampstead Heath						
Highbeech - - -	24	36	5	St. Paul's -	{	61919
Hampstead - -	83	1	13		{	25966
St. Paul's						

As it became necessary to ascertain the situation of a high building near Berkhamstead, which, for distinction sake, I shall style the Gazebo, the instrument was removed from the station on Highbeech, to another farther west of it, as some trees obstructed the view of this object from the former. To get the distance from St. Paul's to this new station, the distance between it and the old one was measured, and found = 460 feet: the angles in the following triangle were also observed.

Highbeech, old station	66°	32′	47″	
Highbeech, new station	113	3	46	
St. Paul's				which gives the distance from

St. Paul's to the new station 61738 feet.

Highbeech, new station -	105	21	44	Gazebo -	{	49631
Berkhamstead Gazebo -	41	55	23		{	28879
St. Paul's - -						
Southwald - -	16	46	15	Epping Windmill	{	46747
Highbeech, old station -	52	16	51		{	17042
Stand of Epping Windmill						
Severndroog Tower -	10	8	44	Epping Windmill	{	81891
Highbeech - - -	122	10	35		{	17043
Stand of Epping Windmill						

Names of Stations.	Observed angles.	Distances.		Feet.
	° ′ ″			
Highbeech, old station -	99 19 16	} Epping Windmill -	{	17649
Berkhamstead Gazebo -	17 42 23		{	55507
Stand of Epping Windmill				

At the new station on Highbeech, the angle between the staff on the Gazebo at Berkhamstead and the old station was observed, and found to be 141° 45′ 50″. This angle, with the measured distance between the stations, and also the distance from the Gazebo to the new station, which are respectively 460 and 49628 feet, gives 49987 feet, for the distance between the new station on Highbeech and Berkhamstead Gazebo.

Hatfield Broad Oak Steeple -	39 1 0	} Hatfield Broad Oak -	{	87140
Berkhamstead Gazebo -	43 12 50		{	60219
Epping Windmill -				
Berkhamstead Gazebo -	24 9 56	} Nazeing - -	{	39473
Hatfield Broad Oak - -	17 19 38		{	52844
Nazeing Steeple				
Hatfield Broad Oak -	107 39 57	} Henham on the Mount	{	39265
Berkhamstead Gazebo -	20 41 30		{	105890
Henham on the Mount Steeple				
Hatfield Broad Oak -	71 28 54	} Thorley - -	{	24275
Henham on the Mount -	36 6 30		{	39058
Thorley Steeple				
Henham on the Mount -	35 25 0	} Atterbury - -	{	37882
Thorley Steeple - -	69 33 0		{	23430
Atterbury Steeple				
Henham on the Mount -	87 20 0	} Rickling - -	{	17816
Thorley - - -	24 57 50		{	42169
Rickling Steeple				
Henham on the Mount -	20 54 0	} Elmdon - -	{	45275
Rickling - -	146 35 0		{	29327
Elmdon Steeple				

The angle between Albury and Elmdon Steeples was observed, at Henham on the Mount, and found to be 72° 47′ 38″. The distances from the former stations to the latter are 37882 and 45275 feet, which give the following triangle:

Henham - 72° 47′ 38″
Albury - 60 28 27
Elmdon - - 46 43 35, from whence we get the distance between Albury and Elmdon = 49701 feet.

Names of Stations.	Observed angles.	Distances.	Feet.
Henham on the Mount	106 30 50	Thaxted - -	22988
Elmdon - - - -	23 2 40		56302
Thaxted Steeple			
Elmdon - - -	71 54 10	Balsham - - -	55262
Thaxted - - -	53 18 44		65504
Balsham Steeple			
Elmdon - - - -	23 38 46	Babraham Mount -	43559
Balsham - - - -	48 40 38		23251
Babraham Mount Station			
Elmdon - - - -	29 46 30	Triplow - -	24806
Babraham Mount - - -	32 36 30		29185
Triplow Steeple			

The angle at Henham on the Mount, between Hatfield Broad Oak and Thaxted Steeples, is 109° 10′ 44″; and the distances of the latter stations from the former one are 39266 and 22988 feet; from these *data* we have the triangle,

Henham - - 109° 10′ 44″
Thaxted - - 45 56 29
Hatfield Broad Oak - 24 52 47, which gives 51608 feet for the distance of Thaxted from Hatfield Broad Oak.

Hatfield Broad Oak - -	51 9 50	High Easter -	24858
Beauchamp Roding - -	64 26 10		21400
High Easter Steeple			
Severndroog Tower - -	21 6 9	Hornchurch - -	50089
Langdon Hill - -	24 10 20		44832
Hornchurch Steeple			
Langdon Hill - - -	77 57 33	Hornchurch -	44837
Gravesend - - - -	50 59 0		56438
Hornchurch Steeple			

Names of Stations.	Observed angles.	Distances.	Feet.
Gravesend - - - -	° ′ ″		
Hornchurch - - - -	24 32 30	Purfleet Cliff -	35517
Purfleet Cliff Station	31 26 22		28282
Severndroog Tower - -	39 44 2	Barking - -	25383
Hornchurch - - - -	27 10 44		35404
Staircase of Barking Steeple			
Severndroog Tower - -	39 41 6	Westham - -	28046
St. Paul's - - - -	44 15 27		25662
Westham Steeple			

ART. XXXIX. *Secondary Triangles.*

St. Paul's from Severndroog Tower 39962 feet.

Severndroog Tower - -	13 1 7	Limehouse -	26371
St. Paul's - - - -	22 36 13		15456
Limehouse Steeple			
Severndroog Tower - -	9 15 39	Chigwell - -	57757
Highbeech - - - -	32 36 38		47842
Chigwell Steeple			
Severndroog Tower - -	11 57 6	Billericay - -	40011
Frierning - - - -	74 34 30		21506
Billericay Chapel			
Westham Steeple - -	45 58 0	Station - -	15640
Staircase of Barking Steeple -	68 35 0		12077
Station on Bank of the Thames			
Station on Bank of the Thames	41 21 0	Perry's Mast House	13120
Westham Steeple - -	56 15 0		10424
Perry's Mast House			
Hornchurch - - -	14 31 20	Chimney - -	33236
Staircase of Barking Steeple	68 52 0		9005
Chimney of Public House at Barking Creek			
Purfleet Cliff - - -	54 57 0	Guzzard - -	21002
Hornchurch - - -	46 40 40		23638
Guzzard Station			

Names of Stations.	Observed angles.			Distances.		Feet.
	°	′	″			
Purfleet Cliff	34	11	30	Rainham		16387
Hornchurch	32	1	0			17370
Rainham Steeple						
Purfleet Cliff	81	9	0	Belvidere		16212
Hornchurch	31	50	50			30369
Lord Eardley's, Belvidere						
Purfleet Cliff	42	18	30	Cold Harbour		10971
Rainham	41	45	0			11090
Station at Cold Harbour						
Guzzard	56	8	20	Aveley Mill		21436
Hornchurch	56	43	20			21302
Aveley Mill						
Purfleet Cliff	34	2	40	Valence Tree		36305
Hornchurch	95	3	40			20404
Valence Tree						
Gravesend	79	39	30	Chadwell		17008
Severndroog Tower	13	41	20			70717
Chadwell Steeple						
Gravesend	35	39	0	Greys		18479
Chadwell Steeple	79	31	20			10953
Greys Steeple						
Gravesend	37	46	0	Flagstaff		22880
Chadwell Steeple	94	24	0			14054
Flagstaff on Mr Button's House						
Gravesend	51	43	0	West Thurrock		22457
Chadwell Steeple	80	2	30			17897
West Thurrock Steeple						
Gravesend	49	8	30	Horndon		33382
Hornchurch	36	7	5			42833
Horndon Spire						
Gravesend	18	52	0	West Tilbury		5617
Chadwell	59	26	30			14956
West Tilbury Steeple						
Gravesend	69	31	27	Northfleet		8755
Chadwell	30	27	42			16179
Northfleet Steeple						

Names of Stations.	Observed angles.			Distances.		
	°	′	″			Feet
Gravesend	37	16	0	East Tilbury		16328
Chadwell	59	13	30			25987
East Tilbury Flagstaff						
Chadwell	51	23	0	Station		25326
Mr. Button's Flagstaff	95	22	30			20051
Station near Ockendon						
Mr. Button's Flugstaff	54	20	30	Orset		17360
Station near Ockendon	54	54	30			17240
Orset Steeple						
Gravesend	45	9	15	Fobbing		41439
Halstow	62	0	10			33270
Fobbing Steeple						
Hadleigh Station	65	31	12	Fobbing		26221
Halstow	45	48	50			33879
Fobbing Steeple						
Halstow	101	39	27	Thundersley		41342
Gravesend	37	16	40			
Thundersley Steeple						
Halstow	17	53	10	Hadleigh		3713
Hadleigh	117	13	23			37028
Hadleigh Spire						
Hadleigh	89	20	40	Leigh		25735
Halstow	24	54	27			37359
Leigh Steeple Staircase						
Halstow	74	23	21	Leigh		27359
Sheppey Station	42	26	8			33325
Leigh Steeple Staircase						
Halstow	13	17	45	Sheerness		41434
Sheppey	46	5	47			13063
Sheerness Fort Flagstaff						
Hadleigh	58	43	29	South Church		71211
Sheppey	21	56	26			74461
South Church Steeple						
Hadleigh	11	6	2	Prittlewell		27208
Sheppey Station	80	16	46			5314
Prittlewell Steeple						

Names of Stations.	Observed angles.			Distances.		
	°	′	″			Feet.
Canewden Steeple	45	50	0	Little Wakering		23850
Prittlewell	60	46	30			19603
Little Wakering Steeple						
Canewden	64	27	0	Bank		32739
Prittlewell	67	46	30			31908
Bank Flagstaff						
Prittlewell	33	10	0	Shoebury-ness		21208
Station on Bank	39	20	30			18302
Shoebury-ness						
Canewden	32	51	30	Foul-ness		35481
Bank Flagstaff	81	20	0			19473
Foul-ness Chapel						
Rayleigh	47	28	6	Signal Staff		71622
Peldon	43	45	33			76311
Foul-ness Signal Staff						
Tillingham Steeple	139	21	10	Signal Staff		13990
Peldon	9	44	29			53860
Signal Staff, Tillingham Grange						
Tillingham	43	27	58	Signal Staff		18802
Peldon	24	10	18			31591
Signal Staff, Bradwell Point						
Tillingham	31	2	40	Brightlingsea		56094
Peldon	100	56	20			29463
Brightlingsea Steeple						
Tillingham	39	48	40	Tolesbury		24611
West Mersey Steeple	57	33	13			18673
Tolesbury Steeple						
Tillingham	63	55	6	Althorn		31946
Triptree, old Station	35	34	3			49330
Althorn Church						
Tillingham	26	32	10	Burnham		26664
Althorn	55	49	0			14400
Burnham Steeple						
Tillingham	47	33	35	Toleshunt		36541
Peldon	56	33	25			32317
Tolesbunt Major Steeple						

Names of stations.	Observed angles.	Distances.	
	° ′ ″		Feet.
Prittlewell Steeple	33 10 0	Signal Staff	21208
Bank Flagstaff	39 20 30		18302
Signal Staff, Shoebury-ness			
Triptree, new Station	38 5 18	Maldon	19425
Danbury	30 11 27		23829
Maldon Spire			
Triptree, new Station	36 48 30	Purleigh	36118
Danbury	72 9 0		22734
Purleigh Steeple			
Danbury	17 47 32	Steple	49647
Purleigh Steeple	148 16 30		28850
Steple Steeple			
Danbury	26 17 49	Hockley	41401
Canewden	51 8 0		23565
Hockley Steeple			
Danbury	27 21 50	Hockley	41400
Rettenden	109 22 0		20170
Hockley Steeple			
Danbury	53 39 40	Rettenden	30079
Canewden	35 25 0		41810
Rettenden Steeple			
Rettenden	34 41 0	Stow, St. Mary's	23571
Canewden	30 53 0		20131
Stow, St. Mary's Steeple			
Rayleigh	71 51 18	Rettenden	20760
Langdon Station	27 38 45		42526
Rettenden Steeple			
Rayleigh	51 8 10	Runwell	21207
Langdon	28 10 20		34975
Runwell Steeple			
Danbury	48 57 22	Burghstead	53254
Rayleigh	72 39 17		42079
Great Burghstead Steeple			
Danbury	59 11 7	Hanningfield	17666
Gallywood Station	41 40 10		22822
East Hanningfield Steeple			

Names of stations.	Observed angles.	Distances.	Feet.
	° ′ ″		
Frierning Steeple	36 7 48	Stock	16826
Danbury	15 38 36		36793
Stock Steeple			
Triptree, old Station	18 38 11	Southminster	55075
Tillingham Steeple	83 33 14		17711
Southminster Steeple			
Peldon Steeple	97 35 31	Layer Marney	20180
Tillingham	23 54 4		49369
Layer Marney Steeple			
Peldon	80 20 6	Signal Staff	60701
Tillingham	61 39 24		67990
Signal Staff, St. Osyth Point			
Thorp Steeple	143 7 36	Signal Staff	21517
Little Bentley	18 54 29		39844
Great Clackton Signal Staff			
Thorp	71 35 55	Great Clackton	18920
Peldon	16 58 13		61508
Great Clackton Steeple			
Dover Court Steeple	24 36 48	Finton	38998
Thorp	92 26 41		16257
Finton Steeple			
Dover Court	39 16 34	Signal Staff	34686
Thorp	70 11 16		23540
Finton Signal Staff			
Dover Court	53 15 26	Walton	26275
Thorp	47 52 22		28389
Walton Tower or Sea-mark			
Dover Court	133 57 30	Cupola	15085
Thorp	13 29 57		46517
Cupola, Landguard Fort			
Thorp	46 16 17	Ardleigh	47494
Peldon	47 1 34		46901
Ardleigh Steeple			
Peldon	106 10 16	Frating	35433
Great Tey Steeple	32 32 11		63274
Frating Steeple			

Names of Stations.	Observed angles.			Distances.	Feet.
	°	′	″		
Thorp	30	17	55	Thorrington	23890
Little Bentley Steeple	90	41	23		12053
Thorrington Steeple					
Dover Court	22	10	12	Kirby	30343
Thorp	59	48	37		13247
Kirby Steeple					
Dover Court	33	8	12	Little Oakley	12216
Kirby Steeple	18	22	0		21193
Little Oakley Steeple					
Tillingham	38	45	0	Toleshunt Major	36541
Layer de la Hay Steeple	45	28	0		32082
Toleshunt Major Steeple					
Dover Court	16	48	13	Buntham	42590
Tattingstone Steeple	98	26	0		12447
Brantham Steeple					
Dover Court	30	52	58	Harkstead	19946
Rushmere Steeple	16	51	2		35319
Harkstead Steeple					
Dover Court	33	17	30	Arwarton	13053
Tattingstone	14	20	0		28941
Arwarton Steeple					
Tattingstone	66	10	0	Bradfield	20998
Arwarton Steeple	43	12	0		28059
Bradfield Steeple					
Dover Court	72	48	50	Harwich	8881
Rushmere	9	58	0		49036
Harwich Spire					
Dover Court	56	48	20	Hollesley	57475
Rushmere	67	58	30		51881
Hollesley Steeple					
Dover Court	47	7	40	Shottisham	52205
Rushmere	68	4	20		41224
Shottisham Steeple					
Dover Court	65	59	15	Bawdsey	46177
Rushmere	52	42	10		53024
Bawdsey Steeple					

Names of Stations.	Observed angles.				Distances.		Feet.
	°	′	″				
Dover Court - -	52	48	11	}	Felixstow - -	{	28926
Woodbridge Steeple -	28	31	0				48262
Felixstow Signal Staff							
Dover Court - -	45	32	55	}	Bawdsey - -	{	42265
Woodbridge - -	44	53	0				42510
Bawdsey Signal Staff							
Rushmere - - -	45	41	10	}	Orford - -	{	75267
Falkenham Steeple -	103	52	10				55472
Orford Steeple							
Woodbridge - -	28	28	0	}	Rendlesham -	{	21686
Butely Steeple - -	34	37	0				18204
Rendlesham Steeple							
Butely - - -	153	23	0	}	Orford - -	{	15762
Rendlesham - -	12	20	0				33057
Orford Steeple							
Dover Court - -	8	2	6	}	Kesgrave - -	{	7371
Rushmere - -	66	54	0				48505
Kesgrave Steeple							
Dover Court - -	34	14	16	}	Waldringfield -	{	45360
Rushmere - - -	62	15	50				28841
Waldringfield Steeple							
Dover Court - -	30	58	10	}	Whertstead - -	{	40331
Kesgrave Steeple - -	56	8	30				24993
Whertstead Steeple							
Falkenham - - -	30	59	0	}	Nacton - -	{	25098
Rushmere - - -	36	2	50				21959
Nacton Steeple							
Dover Court - -	13	29	58	}	Capel - -	{	55220
Stoke - - -	22	45	20				33325
Capel Steeple							
Stoke - - -	24	14	18	}	Hintlesham - -	{	40700
Capel Steeple - -	103	0	34				17186
Hintlesham Steeple							
Stoke - - -	29	43	10	}	Bildestone - -	{	42238
Lavenham Steeple - -	61	31	40				23821
Bildestone Steeple							

Names of Stations.	Observed angles.	Distances.	Feet.
Stoke Bildestone Steeple *Aldham Steeple*	° ′ ″ 33 53 40 48 50 10	Aldham	32055 23746
Lavenham Naughton *Hadleigh Spire*	29 39 50 93 17 20	Hadleigh	42673 21154
Lavenham Naughton Steeple *Lindsey Steeple*	31 40 10 42 21 50	Lindsey	25138 19587
Stoke Lavenham *Newton Steeple*	23 7 30 24 48 40	Newton	27153 25413
Stoke Newton *Grotton Steeple*	27 1 0 42 49 0	Grotton	19660 13140
Bulmer Steeple Glemsford Steeple *Waldingfield Steeple*	67 27 40 53 37 50	Waldingfield	25637 29407
Lavenham Glemsford *Acton Steeple*	56 59 0 33 6 50	Acton	14065 21097
Lavenham Bulmer *Beauchamp Church, St. Paul's*	26 13 10 91 21 20	Beauchamp	41546 18300
Lavenham Topplesfield Steeple *High western part of Hedingham Castle*	12 31 50 52 7 20	Hedingham Castle	59359 16316
Lavenham Bulmer *Ridgewell Steeple*	26 57 0 123 32 0	Ridgewell	62345 33886
Stoke Steeple Naughton Steeple *Langham Steeple*	101 57 15 20 32 45	Langham	17904 49907
Stoke Steeple Great Tey Steeple *Great Horksley Steeple*	21 17 20 8 23 40	Great Horksley	13615 33859

Names of Stations.	Observed angles.			Distances.		Feet.
	°	′	″			
Stoke	71	21	0	Great Horksley		13615
Twinestead Steeple	19	53	0			37819
Great Horksley Steeple						
Stoke	44	24	0	Mount Bures		29360
Great Horksley	109	43	0			21821
Mount Bures Steeple						
Stoke	62	30	40	Earles Colne		47756
St. Mary's, Colchester	70	48	0			44860
Earles Colne Steeple						
Great Tey	24	47	20	West Bergholt		21357
St. Mary's Colchester	33	14	0			16339
West Bergholt Steeple						
Danbury	6	6	0	Braxted		41358
Great Tey	6	56	40			36349
Braxted Steeple						
Great Tey	4	37	24	Kelvedon		36349
Braxted Steeple	11	43	36			10407
Kelvedon Steeple						
Great Tey	30	14	50	Messing		22390
Kelvedon	58	32	0			13223
Messing Steeple						
Great Tey	51	43	10	East Thorp		15462
Kelvedon	36	4	0			20016
East Thorp Steeple						
Danbury	50	48	0	Black Notley		51487
Triptree, new station	85	12	30			40039
Black Notley Steeple						
Danbury	23	51	34	Witham		35850
Triptree, old station	77	29	26			14852
Witham Steeple						
Danbury	47	47	25	Tarling		31874
Triptree, old station	58	17	35			27751
Tarling Spire						
Danbury	51	43	0	Braintree		58918
Triptree, old station	90	45	50			46252
Braintree Steeple						

Names of Stations.	Observed angles.			Distances.		Feet.
	°	′	″			
Triptree, new station	56	13	54			63574
Gallywood station	64	47	51	Feltstead		58409
Feltstead Steeple						
Danbury	26	31	30	Braintree		58918
Feltstead Steeple	73	49	10			27392
Braintree Steeple						
Danbury	17	39	30	Feltstead		60336
Pleshley Steeple	116	15	43			20409
Feltstead Steeple						
Triptree, new station	27	23	20	Hatfield Peverel		20267
Danbury	27	35	30			20132
S. Spire of Hatfield Peverel Abbey						
Pleshley	68	3	0	Great Leigh		24915
Feltstead	64	21	0			25635
Great Leigh Steeple						
Danbury	41	29	44	Great Baddow		16345
Pleshley	16	39	0			37796
Great Baddow Steeple						
Danbury	23	59	8	Chelmsford		24110
Pleshley	20	21	0			28186
Chelmsford Spire						
Danbury	32	38	36	Whittle		33552
Pleshley	41	51	20			27122
Whittle Steeple						
Danbury	19	16	20	Willingale Spain		60488
Hatfield Broad Oak	35	29	15			34390
Willingale Spain Steeple						
Pleshley	36	12	0	Roxwell		19937
Gallywood station	26	14	36			26630
Roxwell Steeple						
Pleshley	103	44	45	White Roding		33489
Gallywood station	34	9	50			57926
White Roding Steeple						
Southwenld Steeple	27	51	51	Doddinghurst		17880
Friering Steeple	30	14	50			16590
Doddinghurst Steeple						

Names of stations.	Observed angles.	Distances.	Feet.
Southweald Epping Windmill *Theydon Mount Steeple*	° ′ ″ 3 49 0 7 31 0	Theydon	31098 15824
Southweald Theydon Mount Steeple *Navestock new Windmill*	49 13 0 16 26 0	Navestock	9656 25846
Southweald Theydon Mount *Theydon Garnon Steeple*	5 18 0 149 43 0	Theydon Garnon	37107 6797
Theydon Mount Theydon Garnon *Havering Steeple*	111 19 30 53 38 0	Havering	21090 24397
Severndroog Tower Highbeech Station *Cupola of a house at Woodford*	5 40 20 14 49 4	Cupola	52260 20197
Southweald Highbeech *Ruins near Ilford*	36 20 20 65 36 20	Ruins	51340 33405
Highbeech St. Paul's *Cheshunt Station*	102 38 0 26 2 0	Cheshunt	34702 77151
Berkhamstead Gazebo Nasing Steeple *Hunsdon Steeple*	25 59 0 88 51 24	Hunsdon	43157 18911
Nasing Hunsdon Steeple *Broxbourn Steeple*	94 35 0 34 41 0	Broxbourn	13899 24348
Berkhamstead Gazebo Hatfield Broad Oak Steeple *Harlow Steeple*	8 33 28 20 11 11	Harlow Steeple	62528 26964
Hatfield Broad Oak Nasing *Sabridgeworth Steeple*	19 44 10 11 48 5	Sabridgeworth	21054 34763
Thorley Steeple Albury Steeple *Great Hadham Steeple*	45 17 0 40 29 0	Great Hadham	15253 16995

Names of stations.	Observed angles.	Distances.	
	° ′ ″		
Henham on the Mount Steeple	31 43 34	Bishop Stortford -	30524
Albury Steeple - -	53 24 6		19993
Bishop Stortford Steeple			
Henham on the Mount -	42 32 24	Stanstead Mountfitchet	36575
Albury - - -	23 35 3		28009
Stanstead Mountfitchet Steeple			
Henham on the Mount -	31 3 0	Farnham - -	24429
Stanstead Mountfitchet -	109 2 0		13323
Farnham Steeple			
Henham on the Mount -	38 33 0	Meesdon - -	39054
Albury - - -	73 13 10		25402
Meesdon Windmill			
Henham on the Mount -	40 10 40	Octagon Lodge -	21677
Elmdon Steeple - -	25 58 10		31938
Chimney on an octagon Lodge			
Balsham Steeple - -	25 15 8	Shady Camps - -	23742
Elmdon - - -	25 0 22		53410
Shady Camps Steeple			
Balsham - - -	31 7 10	Ashdon - -	30778
Shady Camps - -	99 19 0		16120
Ashdon Steeple			
Danbury - - -	9 35 0	Little Saling -	76469
Thaxted Spire - -	26 0 9		28886
Little Saling Steeple			
Elmdon - - -	22 27 0	Newport - -	26498
Rickling Steeple - -	64 25 0		11216
Newport Steeple			
Danbury - - -	7 53 6	Stebbing - -	72806
Little Saling Steeple -	61 38 0		11198
Stebbing Steeple			

ART. XL. *Principal Triangles for the Survey of the Western Part of Kent. Plate* XXXIII.

Frant Steeple from Botley Hill 90362,4 feet.

Names of stations.	Observed angles.	Distances.	Feet.
Frant Steeple Botley Hill *Sevenoaks old Windmill*	° ′ ″ 22 17 10 32 52 47	Sevenoaks	58492 44032
Frant Sevenoaks Windmill *Chiddingstone Steeple*	22 17 10 40 52 50	Chiddingstone	42875 24858
Frant Chiddingstone *Mount Sion Station*	35 2 17 97 43 43	Mount Sion	57874 33532
Frant Mount Sion *East Peckham Steeple*	31 28 30 76 9 30	East Peckham	58964 31707
Mount Sion East Peckham *Tudely Steeple*	48 14 0 65 11 0	Tudely Steeple	31963 25772
Botley Hill Sevenoaks Windmill *Seal Chart Station*	11 1 48 141 42 12	Seal Chart	59563 18388
Seal Chart Sevenoaks Windmill *Tunbridge Steeple*	74 10 0 66 49 0	Tunbridge	26851 28101
Seal Chart Sevenoaks Windmill *Station on Otford Mount*	78 1 0 54 39 0	Otford Mount	20397 24462
Sevenoaks Windmill Otford Mount *Silverden Farm Station*	69 27 0 61 24 0	Silverden Farm	28395 30284

Norwood from Severndroog Tower 39155 feet.

Norwood Severndroog Tower *Well Hill Station*	53 7 40 84 8 0	Well Hill	57393 46155

Names of stations.	Observed angles.	Distances.	
	° ′ ″		Feet.
Severndroog Tower	55 4 14	Crayford	26479
Well Hill	35 0 32	Crayford	37840
Crayford Steeple			
Well Hill	77 37 40	Ash	34738
Crayford	48 8 40	Ash	45555
Ash Steeple			
Ash	53 7 10	Northfleet	32237
Crayford	44 32 4	Northfleet	36767
Northfleet Steeple			
Ash	15 30 4	Gravesend	33664
Northfleet	85 1 8	Gravesend	8762
Gravesend Station			
Ash	47 33 30	Belvidere	56308
Northfleet	97 53 40	Belvidere	41951
Lord Eardley's, Belvidere			
	Gravesend from Halstow 44836 feet.		
Gravesend	31 38 20	Gadshill	22275
Halstow	24 18 20	Gadshill	28388
Gadshill Station			
Halstow	128 34 28		
Sheppey	18 18 3		
Gadshill		Sheppey from Gadshill	70686
Sheppey	88 18 0	Stockbury	43144
Hernhill Steeple	37 2 0	Stockbury	71603
Stockbury Steeple			
Frinstead Steeple	65 27 18	Hernhill	57820
Sheppey	64 9 24	Hernhill	58439
Hernhill Steeple			

ART. XLI. *Secondary Triangles.*

Frant Steeple	26 37 20	Bidborough	26066
Botley Hill Station	9 52 49	Bidborough	68071
Bidborough Steeple			
Frant	20 52 0	Station	27227
Chiddingstone Steeple	29 5 0	Station	19951
Station near Bidborough Church			

Names of stations.	Observed angles.			Distances.		
	°	′	″			Feet.
Frant	104	24	36	Remarkable Tree		24226
Botley Hill	13	40	51			99201
Remarkable Tree near Kibben's Cross						
Frant	46	32	0	Cowden		41943
Station near Bidborough Church	93	3	30			30485
Cowden Steeple						
Station near Bidborough Church	76	2	0	Mount Sion		32194
Chiddingstone Steeple	68	42	0			35532
Mount Sion Station						
Station near Bidborough Church	20	37	0	Leigh		11241
Mount Sion	10	21	0			22031
Leigh Steeple						
Frant	10	5	30	Ide Hill		62547
Chiddingstone	149	38	30			21089
Ide Hill Station						
Chiddingstone	67	42	0	Edenbridge		18639
Ide Hill	49	43	0			22606
Edenbridge Steeple						
Seal Church Steeple	57	45	0	Sevenoaks		15132
Otford Mount	46	5	0			17766
Sevenoaks Steeple						
Mount Sion Station	20	36	0	Hadlow		25291
Peckham Steeple	47	56	0			11987
Hadlow Steeple						
Seal Chart Station	50	45	0	Sundrich		29804
Otford Mount	86	11	0			23131
Sundrich Steeple						
Otford Mount	94	17	0	Seal		9705
Silverden Station	17	20	0			32484
Seal Steeple						
Well Hill Station	17	40	40	Ketson Common Windmill		26538
Norwood	14	5	22			33103
Windmill, Ketson Common						
Well Hill	56	39	0	Flagstaff		28279
Severndroog Tower	37	39	0			38664
Flagstaff on Hayes Common						

Norwood from Severndroog Tower 32155 feet. Between the triangles

Names of Stations.	Observed angles.	Distances.	Feet.
	° ′ ″		
Norwood - - -	65 53 30	Flagstaff - -	30718
Severndroog Tower -	46 30 0		38654
Hayes Common			
Norwood - - -	34 27 30	Flagstaff - -	20391
Hayes Common - -	39 41 0		18068
Flagstaff on Addington Common			
Well Hill - - -	56 11 40	Cudham - -	20860
Norwood - - -	22 44 5		48958
Cudham Steeple			

Well Hill from Otford Mount 19206 feet.

Otford Mount - -	52 11 0	Knockholt Beeches -	22860
Well Hill - - -	73 58 0		18790
Knockholt Beeches, East End			
Well Hill - - -	22 22 46	Race House - -	27859
Crayford Steeple - -	41 17 10		16075
Dome of a Race House			
Well Hill - -	70 25 40	Windmill - -	57560
Norwood - - -	39 36 24		38945
Windmill, Bromley Common			
Well Hill - - -	59 1 0	Farnborough - -	41650
Severndroog Tower -	19 58 0		41381
Farnborough Station			
Well Hill - - -	58 52 0	St. Mary's Cray - -	17255
Farnborough - - -	79 32 0		15019
St. Mary's Cray Steeple			
Well Hill - -	79 42 26	Halstead - - -	8652
Norwood -	8 40 4		56492
Halstead Steeple			
Norwood - - -	36 36 40	Bromley - - -	22696
Severndroog Tower -	32 52 50		24932
Bromley Steeple			
Well Hill - - -	32 29 0	Bromley - - -	36198
Severndroog Tower -	51 13 0		22938
Bromley Steeple			

Names of Stations.	Observed angles.			Distances.		Feet.
	°	′	″			
Well Hill	14	19	0	Hayes		31069
Bromley	51	35	0			9805
Hayes Steeple						
Bromley	45	18	0	Lewisham		19640
Severndroog Tower	51	28	0			17846
Lewisham Steeple						
Severndroog Tower from Chiselhurst Steeple, 36778.						
Severndroog Tower	100	42	0	New Cross		23529
Chiselhurst Steeple	42	22	0			34309
New Cross Station						
Severndroog Tower	38	0	0	Eastcombe Point		18014
New Cross	49	55	0			14496
Eastcombe Point Station						
Severndroog Tower	49	39	0	Woolwich		9628
Eastcombe Point	31	55	0			13879
Woolwich Steeple						
Severndroog Tower	15	1	30	Bexley		23453
Crayford	57	48	20			7185
Bexley Steeple						
Well Hill	61	48	0	Charlton		22835
Crayford	36	39	0			33714
Charlton Farm						
Crayford	23	17	10	Darent		20374
Charlton Farm	28	14	0			17026
Darent Steeple						
Ash Steeple	12	56	49	Dartford Brent		33636
Crayford	30	32	18			14830
Dartford Brent Mill						
Crayford	16	16	18	Stone		21153
Stone Steeple	31	0	0			8069
Dartford Brent						
Ash	15	42	50	Hartley		7869
Northfleet Steeple	4	56	20			24750
Hartley Steeple						
Northfleet	8	40	40	Ridley		33675
Ash	101	42	0			5189
Ridley Steeple						

Names of Stations.	Observed angles.	Distances.	Feet.
Northfleet - -	° ′ ″ 90 15 30	Southfleet - -	10290
Gravesend Station -	49 26 6		13545
Southfleet Steeple			
Gadshill - - - -	28 8 54	Shottenden Mill -	119539
Sheppey Isle - -	121 36 55		66221
Shottenden Windmill			
Gravesend Station - -	40 46 7	Cliff - -	30549
Gadshill - - -	92 28 1		19967
Cliff Steeple			
Gravesend Station - -	35 48 14	Higham - -	14115
Gadshill - - -	76 47 15		23489
Higham Steeple			
Gravesend Station - -	86 16 16	Gravesend -	3373
Halstow Station - -	4 18 19		44747
Gravesend Steeple			
Gravesend - - -	25 8 43	Chalk - -	11621
Halstow - - -	8 11 44		34673
Chalk Steeple			
Gravesend - - -	59 21 48	Lower Hope Point -	28287
Gadshill - - -	72 5 57		25577
Lower Hope Point, Chimney of the Guard Room			
Gravesend - - -	99 28 57	Tilbury Fort -	6539
Gadshill - - -	15 26 18		24128
Flagstaff, Tilbury Fort			
Gadshill - - -	28 52 26	Rainham - -	38245
Sheppey - - -	26 24 42		41527
Rainham Steeple			
Gadshill - - -	128 37 56	Swanscombe - -	36747
Halstow - - -	29 12 53		58814
Swanscombe Spire			
Gadshill - - -	124 43 26	Northfleet -	31034
Halstow - - -	28 58 21		52658
Northfleet Steeple			
Halstow - - -	4 37 23	Southfleet -	57736
Gravesend - -	159 53 20		13534
Southfleet Steeple			

Names of Stations.	Observed angles.	Distances.	Feet.
Gravesend	° ′ ″		
Halstow	38 36 50	Shorn Mill	14947
Shorn Mill	15 44 0		34435
Sheppey	39 22 14	Gillingham	42453*
Stockbury	79 31 3		31257
Gillingham Steeple			
Sheppey	63 7 52	St. James's Church	20164
Gillingham	24 34 17		43257
St. James's Church, Isle of Grain			
Halstow	73 41 28	Gillingham	23822
Sheppey	28 9 15		48453*
Gillingham Steeple			
Gadshill	23 35 24	Friendsbury	11049
Sheppey	4 10 33		60721
Friendsbury Steeple			
Halstow	73 39 6	Star Inn	30617
Sheppey	35 45 47		50270
Chimney of the Star Inn			
Halstow	88 11 56	Bell Inn	47500
Sheppey	44 45 13		67466
High Staff at the Upper Bell Inn			
Sheppey	75 21 37	Hove	59215
Twinestead	50 40 20		4732
Hove Steeple			
Gadshill	17 43 23	Upchurch	44466
Sheppey	25 36 26		32395
Upchurch Spire			
Gadshill	21 19 45	Bobbing	60739
Sheppey	57 20 29		26212
Bobbing Spire			
Sheppey	46 5 47	Flagstaff	13063
Halstow	13 7 45		41434
Flagstaff, Sheerness Garrison			
Sheppey	17 13 51	Hucking	52765
Frinstead	93 18 29		15656
Hucking Spire			

Names of Stations.	Observed Angles.	Distances.	Feet.
	° ′ ″		
Sheppey	29 27 6	Hernhill	58439
East Church Station	136 15 56		41564
Hernhill Steeple			
East Church	44 20 17	Milton	32313
Sheppey	95 42 22		22696
Milton Steeple			
Sheppey	36 56 30	Iwade	12997
Milton	32 24 0		14544
Iwade Steeple			
Hernhill	7 28 0	Witchling	51579
Frinstead	45 6 35		9461
Witchling Steeple			
Hernhill	25 1 0	Tenham	33833
Sheppey	25 51 16		30336
Tenham Steeple			
Tenham	75 31 0	Bapchild	29846
Sheppey	24 42 40		12886
Bapchild Spire			
Sheppey	21 32 42	Sheldwich	56869
Hernhill	75 8 0		21581
Sheldwich Steeple			
Sheldwich	4 41 0	Queenborough	60719
Sheppey	120 20 44		6156
Queenborough Steeple			
Hadleigh	21 19 45	Minster	69035
Sheppey	114 38 31		9771
Minster Steeple			
Halstow	70 9 25	St. Mary's	7095
Hadleigh	11 54 16		32352
St. Mary's Steeple			
Hernhill	29 11 0	Feversham	15630
Sheppey	9 39 22		44537
Feversham Spire			
Tenham	41 29 0	Hartey	20617
Hernhill	36 36 0		22906
Hartey Steeple			

Names of Stations.	Observed Angles.	Distances.	Feet.
Hernhill - - -	° ′ ″ 85 12 0	Sea Salter - -	17031
East Church - - -	22 15 10		43580
Sea Salter Steeple			
Tenham - - - -	105 2 0	Whitstable - -	50935
Sheppey - - - -	48 28 58		65697
Whitstable Steeple			

SECTION FOURTH.

Determination of the Altitudes of the Stations above the Level of the Sea; and the mean Refractions deduced from observed Angles of elevation and depression.

ART. XLII. *Elevations and Depressions.*

At Trevose Head.

The ground at Cadon Barrow - - -	*elevated*	39′ 24″
Bodmin Down - - - -	*elev.*	10 48
St. Agnes - - - -	*depressed*	6 39
Hensbarrow - - - -	*elev.*	29 2

At Bodmin Down.

The ground at Carraton Hill - - - -	*elev.*	27 49
Trevose Head - - - -	*depr.*	22 33
Cadon Barrow - - - -	*elev.*	16 0
Brown Willy - - - -	*elev.*	54 24

Cadon Barrow.

The ground at Trevose Head - - -	*depr.*	36 49
Brown Willy - - - -	*elev*	36 3
The horizon of the sea in the direction of Trevose Head	*depr.*	30 56
Ditto in the direction north - - - -	*depr.*	31 12

St. Stephen's Down.

The ground at Black Down - - - -	*elev.*	25 21
Carraton Hill - - - -	*elev.*	35 18
Brown Willy - - - -	*elev.*	42 9

Black Down, near Lydford.

The ground at Maker Heights	*depr.*	32′	8″
Carraton Hill	*depr.*	3	46
St. Stephen's Down	*depr.*	35	18

Mendip Hills.

The ground at Bradley Knoll	*depr.*	6	12
Westbury Down	*depr.*	14	59
Farley Down	*depr.*	18	21
Lansdown	*depr.*	14	4
Moor Lynch	*depr.*	34	53
Dundry	*depr.*	15	45
Dundon Beacon	*depr.*	38	24
Ash Beacon	*depr.*	20	45

Dundry.

The ground at Mendip	*elev.*	5	8
Farley Down	*depr.*	10	1
Lansdown	*depr.*	3	19

Lansdown.

The ground at Dundry	*depr.*	5	44
Mendip	*depr.*	1	39

Farley Down.

The ground at Westbury	*depr.*	0	12
Mendip	*elev.*	5	51
Dundry	*depr.*	1	46

Bradley Knoll.

The ground at Bull Barrow	*depr.*	8	59
Ash Beacon	*depr.*	20	18
Westbury	*depr.*	4	36

Westbury Down.

The ground at Beacon Hill, Amesbury	*depr.*	10	9
Bradley Knoll	*elev.*	7	1
Mendip	*elev.*	1	28
Farley Down	*depr.*	9	9

Dundon Beacon.

		°	′	″
The ground at Moor Lynch	*depr.*			
Lugshorn Corner	*depr.*	3	56	13
Mendip	*elev.*		28	18
Pilsden	*elev.*		8	38

Moor Lynch.

The ground at Greylock's Foss-way	*depr.*	1	59	14
Lugshorn Corner	*depr.*		32	45
Dundon Beacon	*elev.*		0	9
Mendip	*elev.*		23	11
Pilsden	*elev.*		9	2
Ash Beacon	*elev.*		6	57

Greylock's Foss-way.

The ground at Moor Lynch	*elev.*	1	53	56
Dundon Beacon	*elev.*		34	48
Top of the staff (20 feet high) at Greylock's Foss-way	*elev.*		0	34

Lugsborn Corner.

The ground at Moor Lynch	*elev.*		27	21
Dundon Beacon	*elev.*	1	20	58
Top of the staff (20 feet high) at the west end of the base	*depr.*		1	9

Beacon Hill, Amesbury.

The ground at Westbury	*depr.*		4	36
Inkpin	*elev.*		6	22

Inkpin Hill.

The ground at White Horse Hill	*depr.*		10	54
Highclere	*depr.*		15	0
Beacon Hill, Amesbury			18	24

White Horse Hill.

The ground at Highclere	*depr.*		7	39
Nuffield	*depr.*		12	6
Shotover Hill	*depr.*		17	6

Scutchamfly Barrow.

The ground at Wendover		*depr.*	5′ 36″
	Whiteham Hill	*depr.*	11 20

At Shotover Hill.

The ground at Scutchamfly Barrow		*elev.*	0 20
	Nuffield	*elev.*	1 27
	Wendover	*elev.*	2 58
	White Horse Hill	*elev.*	1 36

Brill on the Hill.

The ground at Nuffield		*depr.*	4 48
	Wendover	*elev.*	3 55
	Bow Brickhill	*depr.*	10 44
	Epwell	*depr.*	6 57
	Stow	*depr.*	7 6
	White Horse Hill	*depr.*	5 45

Nuffield.

The ground at White Horse Hill		*depr.*	4 45
Top of the Staff at Brill on the Hill. Staff 13½ feet high		*depr.*	6 2
	Bagshot	*depr.*	6 43
	Highclere	*depr.*	4 12

N. B. The half stage belonging to the Royal Society was used at this station.

Wendover.

The ground at Brill on the Hill		*depr.*	14 59
	Shotover Hill	*depr.*	17 21
	Bow Brickhill	*depr.*	17 28
	Stanmore	*depr.*	19 57

Stow on the Wold.

The ground at Shotover		*depr.*	13 48
	White Horse Hill	*depr.*	7 30
	Broadway Beacon	*elev.*	11 29
	Brill on the Hill	*depr.*	14 45
	Epwell	*depr.*	8 0

Broadway Beacon.

The ground at Stow		*depr.*	19 0
	Epwell	*depr.*	17 25

Epwell.

The ground at Stow		*depr.*	3' 53"
	Arbury Hill	*depr.*	6 39
	Brill on the Hill	*depr.*	11 51
	Corley	*depr.*	20 8
	Broadway Beacon	*elev.*	8 31

Arbury Hill.

The ground at Epwell		*depr.*	14 25

Bow Brickhill.

The ground at Wendover		*elev.*	3 59
	Kinsworth	*elev.*	5 35
	Brill on the Hill	*depr.*	5 28

Kinsworth.

The ground at Brill on the Hill		*depr.*	12 37
	Bow Brickhill	*depr.*	17 25
	Arbury Hill	*depr.*	13 44
	Stanmore	*depr.*	17 4
	Lillyhoe	*depr.*	23 44

Bagshot Heath.

The ground at Nuffield		*elev.*	1 29
	Stanmore	*depr.*	7 28

Stanmore.

The ground at Bagshot Heath		*depr.*	9 34

ART. XLIII. *Heights of the Stations.*

Stations.	Ground above low water mark. Feet.
Trevose Head	274
St. Agnes Beacon	621
Hensbarrow	1034
Bodmin Down	645
Black Down	1160
St. Stephen's Down	605
Bradley Knoll	973

Stations.	Ground above low water mark. Feet.
Mendip	999
Westbury Down	775
Dundry	790
Lansdown	813
Farley Down	700
Moor Lynch	330
Dundon Beacon	360
Lugshorn Corner	49
Greylock's Foss-way	42
Ash Beacon	655
Cadon Barrow	1011
Brown Willy	1368
Inkpin	1011
Nuffield	757
White Horse Hill	893
Shotover Hill	599
Muzzle Hill, (Brill station)	744
Whitcham Hill	576
Wendover, ground above	905
Bow Brickhill	683
Kinsworth	904
Lillyhoe	664
Stow on the Wold	883
Epwell Hill	836
Broadway Beacon	1086
Arbury Hill	804

ART. XLIV. *Mean Terrestrial Refractions.*

Between	Mean Refractions.
Bodmin Down and Cadon Barrow	$\frac{2}{9}$
Bradley Knoll and Westbury Down	$\frac{1}{8}$
Maker Heights and Black Down	$\frac{1}{8}$
Highclere and Inkpin	$\frac{1}{9}$
St. Agnes Beacon and Trevose Head	$\frac{1}{9}$
Moor Lynch and Lugshorn Corner	$\frac{1}{11}$
Hensbarrow and Trevose Head	$\frac{1}{15}$

Wingreen and Bradley Knoll	1/11
Bodmin Down and Trevose Head	1/11
Carraton Hill and Black Down	1/11
Westbury Down and Mendip	1/11
Carraton Hill and St. Stephen's Down	1/11
Farley Down and Mendip	1/18
Beacon Hill and Westbury Down	1/19
Dundry and Farley Down	1/11
Dundon Beacon and Mendip	1/17
Bradley Knoll and Mendip	1/11
Lansdown and Mendip	1/19
Moor Lynch and Dundon Beacon	1/19
Dundry and Mendip	1/18
Westbury Down and Farley Down	1/11
St. Stephen's Down and Black Down	1/11
Moor Lynch and Dundon Beacon	1/11
Dundon and Lugshorn Corner	1/1
Moor Lynch and Greylock's Foss-way	0
Lugshorn Corner and Greylock's Foss-way	0
Cadon Barrow and horizon of the sea in the direction of Trevose Head	1/11
Ditto in a northern direction	1/11
Brill and Nuffield	1/2
Broadway and Stow	1/19
Epwell and Broadway	1/11
Highclere and White Horse Hill	1/11
Nuffield and White Horse Hill	1/12
Nuffield and Bagshot	1/11
Epwell and Stow	1/11
Brill and Stow on the Wold	1/13
Wendover and Bow Brickhill	1/13
Kinsworth and Bow Brickhill	1/11
Shotover and White Horse Hill	1/11
Epwell and Brill	1/11
Bow Brickhill and Brill	1/11

ART. XLV. *Particulars respecting the Altitudes of the Stations.*

The height of the station on Trevose Head, above the surface of the sea at low water, was determined in 1797, by levelling. The transit instrument was used for the purpose; and there is reason to believe the result, $274\frac{8}{10}$ feet, is within a very few inches of the truth.

In the Philosophical Transactions for 1797, p. 471, the height of the station on Maker Heights is said to be 402 feet; this was also found by levelling. The altitude of St. Agnes Beacon, determined from that station, is 599 feet; (see the same volume and page;) but, if the calculation be made from the base of altitude at Trevose Head, the height of that station, above the level of the sea, will be 621 feet, which gives a difference of 22 feet. It must be recollected, however, that in the first result, the computation was carried through two intermediate stations, which gave three arcs, and as many mean refractions; and, considering the extreme variableness to which refractions are liable, we are assuredly not to consider 22 feet deviation from the truth as a large quantity.

Besides St. Agnes Beacon, the altitudes of Cadon Barrow, Brown Willy, Hensbarrow, and Bodmin Down, have been determined from that of Trevose Head. Of the remaining stations, some are derived from Maker Heights, others from Dunnose: most of them are mean results, that is, each station has generally been found two ways; and, as it will serve to shew what errors proceed from irregularity of refraction, and imperfection of observation, I shall exhibit a few particulars in relation to them.

Height of	deduced from	Feet.	Mean.
Black Down	Maker Heights - -	1169	1160
	Carraton Hill - -	1152	
St. Stephen's Down	Black Down -	609	605
	Carraton Hill - -	600	
Westbury Down	Bradley Knoll -	779	776
	Beacon Hill - -	771	
Farley Down	Mendip Hills -	708	700
	Westbury Down -	696	
Moor Lynch	Mendip Hills - -	835	830
	Ash Beacon -	825	
Lugshorn Corner	Dundon Beacon -	46	49
	Greylock's Foss-way	52	
Inkpin Beacon	Highclere - - -	1014	1011
	Beacon Hill -	1009	
Ash Beacon	Bull Barrow - -	653	655
	Bradley Knoll -	657	

The above will sufficiently shew, what dependence is to be placed on the heights deduced from observed angles of elevation or depression; the results are, indeed, often less consistent, and frequently unsatisfactory; but, generally, they run on a parallel with these. The *data* from which all the heights have been computed, accompany this article.

The measurement of the base on Sedgemoor, shewed a fall of about 7 feet, from Lugshorn Corner to Greylock's Foss-way:

therefore, supposing that fall to be gradual and constant, all the way from the latter station to the surface of the sea at Bridgewater Bay, we shall get 24 feet, for the height of Lugshorn Corner from the surface of the sea. The altitude of this station, deduced from that of Trevose Head, is 49 feet; and, subtracting 3 feet from it, (the height of the bank on which the instrument stood above the moor,) we get 46 feet for the height of the moor at Lugshorn Corner, above the level of the sea at Bridgewater Bay. But this height, *supposing the fall regular*, is proved to be 24 feet. There is, therefore, a difference of 22 feet, granting the whole of this to be an error on the side of the survey: but, as the general surface of the moor at Bridgewater Bay is several feet above the surface of the sea, we may take a moiety of 24 feet, for the error of the computed height of the station at Lugshorn Corner.

ART. XLVI. *Matters relating to Refraction.*

The refractions contained in this account, like those in our former Papers, tend to prove, that when rays of light pass horizontally, and considerably distant from the surface of the earth, they are less bent or refracted from their rectilinear courses, than theory and opinion have laid down as fact. It is very certain, however, that objection lies against particular conclusions drawn from such *data* as we possess; because the angles of elevation and depression of corresponding stations are observed *at different times*, and almost always, therefore, under different circumstances; but, with the experience and continual practice of thus obtaining means of computing these refractions, although we may not be able to determine the refracting power of the air under given circumstances, yet, as the causes which render

it variable, are as likely to predominate when the angles of depression or elevation are observed from low stations as when observed from high ones, we may be enabled to make some general deductions.*

When the instrument formerly made use of by General Roy was intrusted to my care, I possessed the means of determining, in a more accurate manner than had yet been done, the refractive power of the air near the horizon. To devote much time to it, has not, as yet, been in my power; because a more rapid extension of the survey was an object of greater

* As many instances of strong atmospherical refraction have been related, and ingeniously accounted for, in some of the late publications of the Royal Society, I think it right to mention, by way of note, a very extraordinary instance of its variability.

In the month of June, 1795, when the instrument and party were stationed at Pilsden Hill, in Dorsetshire, on a particular day, at about the hour of four, I employed myself in observing the angles of depression or elevation of the surrounding hills. After I had done all that was necessary in this matter, I turned the telescope to *Glastonbury Tor*, and observed the depression of it. The air was so unusually clear, that, desirous of proving to a gentleman then with me in the observatory tent, the excellence of the telescope, I desired him to apply his eye to it: this he did, and, agreeably to a desire he expressed, I again took the depression of the upper part of the old building, which I was enabled to do with great accuracy, and found it 2′ different; the first being 30′,0″, and the last 30′,2″. The unusual distinctness of this object, led me to keep my eye a long time at the telescope; and, whilst my attention was engaged, I perceived the top of the building *gradually rise* above the micrometer wire, and so continue to do, till it was elevated 10′,45″ above its first apparent situation; it then remained stationary, and as night drew on, the object became indistinct. The following evening, I observed the depression again, and found it 29′,50″. To what cause this extraordinary change in the refraction could be owing, I am at a loss to conjecture. The former part of the day had been warm, with little wind, and cloudy. The thermometer, at the time of observation, was 65°, and continued stationary for a considerable time. The sky was cloudy, but yet, as I have before observed, the air was remarkably clear. The top of Glastonbury Tor, I suppose, is about 200 feet from the surface of Sedgemoor, over a considerable tract of which, the line joining Pilsden with that object passes. The gentleman of whom I speak, as being with me in the tent, was Captain Darby, of the Royal Engineers, who, no doubt, well remembers the circumstance.

importance. I did not, however, lose any opportunity which the subsequent season offered; the first was, when the instruments were at White Horse Hill and Whiteham Hill; the second, when one was stationed at Brill and the other at Arbury Hill; and the third opportunity offered itself, when one party was stationed at the latter place and the other at Wendover.

On these occasions, the instructions which I communicated to Mr. WOOLCOT, and by which I governed myself, were to observe the elevation or depression of the corresponding station at the expiration of every hour, beginning at six A. M. and to have the watch well regulated from observed altitudes of the sun's limb. I requested him also to be very minute in entering on his book the state of the weather; to keep the instrument properly sheltered from the wind; to be always cautious to adjust his level; and also to insert the state of the air, as to temperature and density, by noting the thermometer and barometer.

During the time we were at the two first stations, White Horse and Whiteham Hills, there was only one day when the air was sufficiently clear for the purpose; this was the 6th of June. On that day, the following observations were made *at the same time as shewn by signal.*

Whiteham Hill. June 6th, 1799.

Hours.	Wh. Horse H. Elevated.	Barometer.	Thermometer.	Remarks.
	° ′	In. pts	Degrees.	
3	6 4	29,730	60.3	Light airs at SW. Sun not shining; remarkably clear.
4	6 24	29,724	62.5	Ditto. Ditto. ditto.
5	6 14	29,725	58.7	Ditto. Ditto ditto.
6	6 10	29,732	58.5	Ditto. Ditto ditto.
7	6 11	29,728	57.5	Ditto. Ditto ditto.
8	6 21	29,733	57	Very calm, and cloudy, but clear.
9	5 37	29,736	55.7	Ditto. Lamp at Shotover very bright. Dew falling.
10	5 39	29,749	55.5	Ditto. Ditto.

White Horse Hill. June 6th.

Hours.	Whiteham H. Depressed.	Barometer.	Thermometer.	Remarks.
	′ ″	In. pts.	Degrees.	
3	18 21	29.412	57,7	Light airs at SW. Sun not shining; very clear.
4	18 16	29,408	59,5	Ditto. Ditto. ditto.
5	18 24	29,410	57,6	Ditto. Sun shining a little; not so clear.
6	18 20	29,412	55,5	More wind. Sun not shining, and darker.
7	18 25	29,412	55,5	Calm and cloudy.
8	18 15	29,438	54,2	Quite calm, and a little dew falling.
• 9	18 10	29,438	53,4	Ditto. Fine night. Lamp at Whiteham very distinct.
• 10	18 25	29,438	53,2	Ditto, but lamp rather indistinct.

Similar observations were also made when the instruments were at Brill and Arbury Hill: they were as follows.

Arbury Hill. July 11th, 1799. Watch regulated.

Hours.	Brill, Depressed.	Barometer.	Thermometer.	Remarks.
	′ ″	In. pts.	Degrees.	
9 A.M.	11 15	29,180	65 ,5	Light airs at SW. Cloudy, but sun shining now and then.
10	11 15	29,200	70 ,0	Ditto. Cloudy.
11	11 15	29,200	70 ,7	Ditto. Ditto.
12	11 6	29,199	70 ,2	Ditto. Ditto.
3 P.M.	11 6	29,162	68 ,0	Ditto. Ditto. Very clear.
4	10 5	29,168	72 ,5	Ditto. Sun shining a little, yet free from any tremor.
• 9	10 30	29,132	63 ,0	Ditto. Lamp at Brill perfectly distinct.

Brill on the Hill. July 11th, 1799. Watch regulated.

Hours.	Arbury H Depressed.	Barometer.	Thermometer.	Remarks.
	′ ″	In. pts.	Degrees.	
9 A.M.	8 40	29,100	61 ,0	Light airs at SW. Appearances of rain from SW. Cloudy.
10	8 36	29,210	67 ,5	Ditto. Clearer, but cloudy. Arbury Hill very distinct.
11	8 36	29,210	67 ,5	Ditto. More cloudy and equally clear. [round.
12	8 36	29,210	65 ,0	The air remarkably clear and free from tremor. Cloudy all
3 P.M.	8 36	29,210	71 ,0	Ditto ditto. More cloudy.
4	8 46	29,250	71 ,5	ditto. Not so cloudy.
• 9	8 48	29,200	62,75	The lamp at Arbury H. very bright. A very fine quiet night.

The next opportunity which offered, was at the former station and Wendover: the observations were as follows.

Arbury Hill, July 27th, 1799. Watch regulated.

Hours.	Wendover, Depressed.	Barometer.	Thermometer.	Remarks.
	′ ″	In. pts.	Degrees.	
12	12 8	28,728	62 ,0	Fresh wind from SW. Rather dark weather, sun shining here [and there.
1	12 3	28,734	64 ,2	Ditto. Air tremulous, ditto.
2	12 11	28,740	64 ,0	Ditto. Ditto, ditto.
3	12 10	28,738	63 ,5	Ditto. Air more steady, ditto. Clearer.
4	12 22	28,740	64 ,0	Ditto. Very steady. Sun shining a little.
5	11 50	28,740	64 ,2	Ditto, Ditto. Ditto.
6	12 17	28,740	61 ,0	Less wind, and the air very clear. Wendover perfectly distinct.

Wendover. July 27th, 1799. Watch regulated.

Hours.	Arbury H. Depressed.	Barometer.	Thermometer.	Remarks.
	′ ″	In. pts	Degrees	
5 A.M.	16 12	29.030	53 ,2	Wind at SW, rather fresh; sun shining, and air very clear.
6	16 12	29.030	53 ,0	Ditto, ditto.
7	15 26	29.030	54 ,5	Less wind, and the air very steady. Arbury Hill very distinct.
8	14 44	29.100	54 ,0	Little wind. Dew falling very fast. Ditto.

Another opportunity for making contemporary observations occurred, when the parties were on Broadway Beacon and Epwell: I place them last, because I think them inferior to the others.

Epwell. June 26th, 1799. Watch regulated.

Hours.	Broadway B. Elevated.	Barometer.	Thermometer.	Remarks.
	′ ″	In. pts.	Degrees.	
12	6 6	29.100	60.5	Wind SW. Cloudy. Much rain preceding night.
1P.M.	6 8	29,100	63,2	Ditto, but calmer; sun not shining at Broadway.
2	6 12	29.208	69.7	Very calm, and cloudy all round.
3	6 20	29,100	59,0	Ditto. Appearances of rain in SW quarter.
4	8 32	29.100	57,5	Foggy, but easily perceive the tent at Broadway Beacon.

Broadway Beacon. June 26th, 1799. Watch regulated.

Hours.	Epwell. Depressed.	Thermometer.	Remarks.
	′ ″	Degrees.	
2	19 0	57,5	Light airs from SW. Inclinable to rain.
3	19 2	57,5	Ditto. Still more so.
4	19 3	57.5	Ditto, but misty. Barometer tube broken.

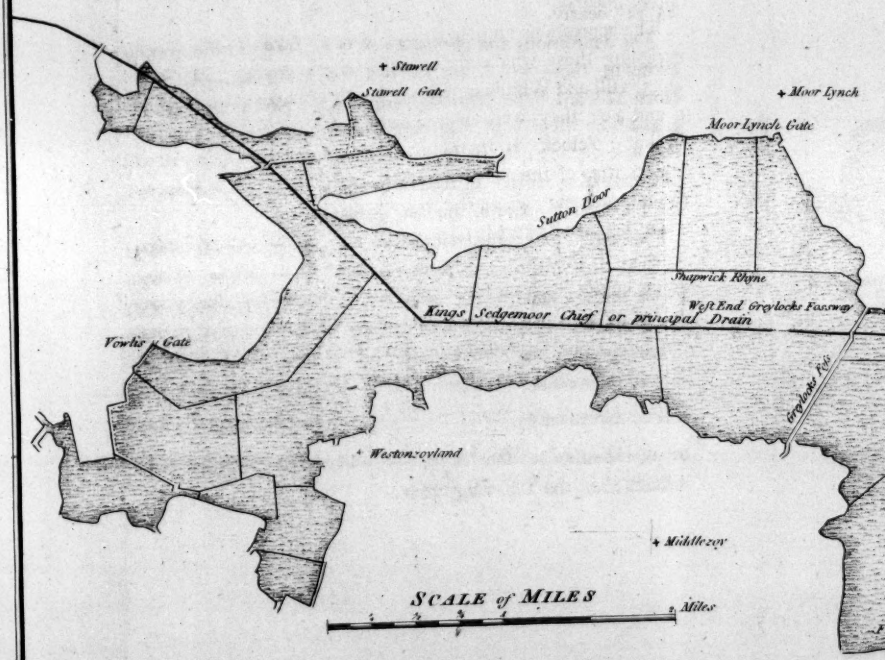
To determine the refractions on the first arc, White Horse and Whiteham Hills, we have the distance between those stations = 88662,2 feet, which subtends an arc of 14′ 32″ nearly.

To determine those on the second, we have the distance between Brill and Arbury Hill = 146530 feet, subtending an arc of 24′ 8″,9: those on the third, Wendover and Arbury Hill, 210628 feet = 34′ 35″; and, for finding the refractions from the two last tables, we have the distance from Broadway Beacon to Epwell = 80611,4 feet, which subtends an arc of 13′ 11″ nearly.

The depressions and elevations were all taken to the ground, excepting those which are marked with asterisks. At White Horse Hill and Whiteham Hill, lamps were used at the hours of 9 and 10: they were also made use of at Arbury Hill and Brill at 9 o'clock. In the first instances, the lamps were placed (the centres of them) $1\frac{1}{2}$ feet from the bottoms of the respective instruments; and in the last $2\frac{1}{2}$ feet.

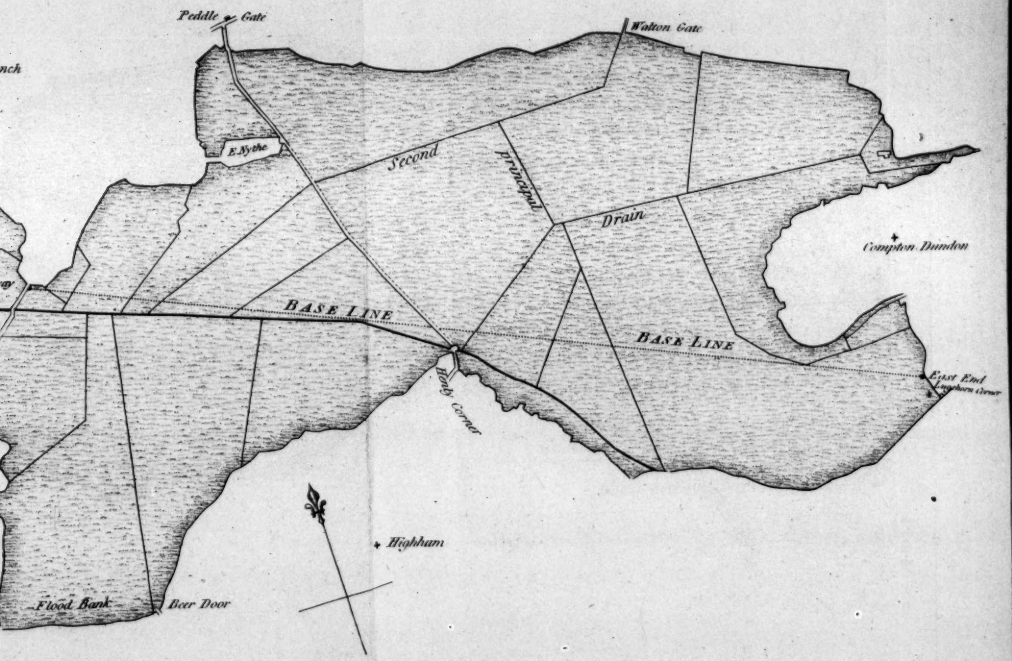
The height of the transit telescope above the ground was always $5\frac{1}{2}$ feet; therefore, an allowance must be made, at each station, for the angle which that space subtends at its corresponding one; this premised, the refraction will be found from one of the two following rules, *viz.* if A be the contained arc, and D d the observed depressions, the quantity answering to the refraction, R, will be expressed by $\frac{A - D - d}{3}$; or, if one of the angles should be an elevation, e, then $R = \frac{A + e - d}{2}$: these rules give the refractions in the following table.

# of KING'S SEDGEMOOR



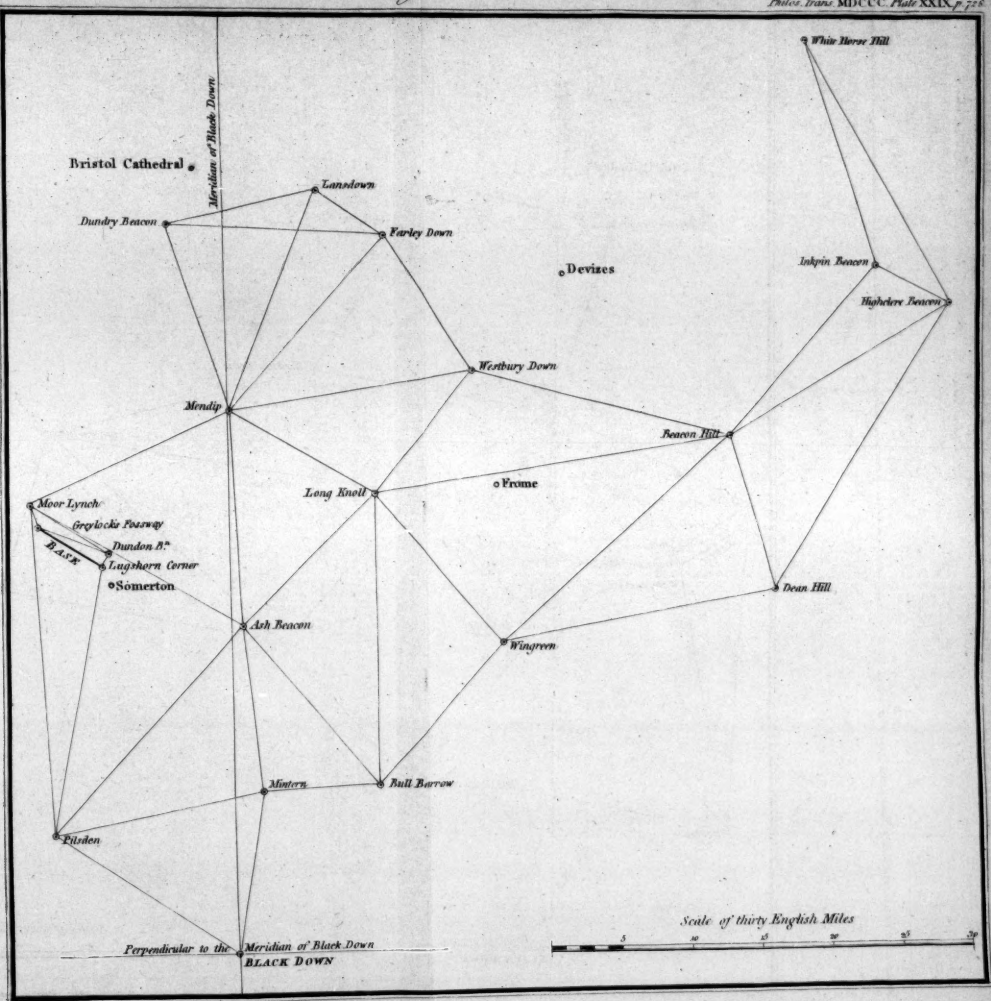
A Plan

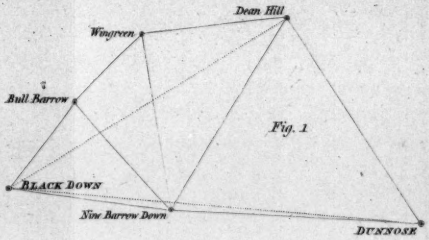
R with the BASE LINE measured thereon.



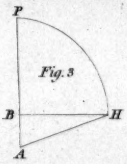
PLAN of the Principal Triangles in the TRIGONOMETRICAL SURVEY, 1798.

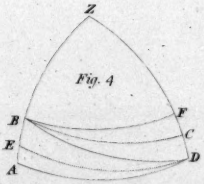
Philos. Trans. MDCCC. Plate XXIX. p. 728.



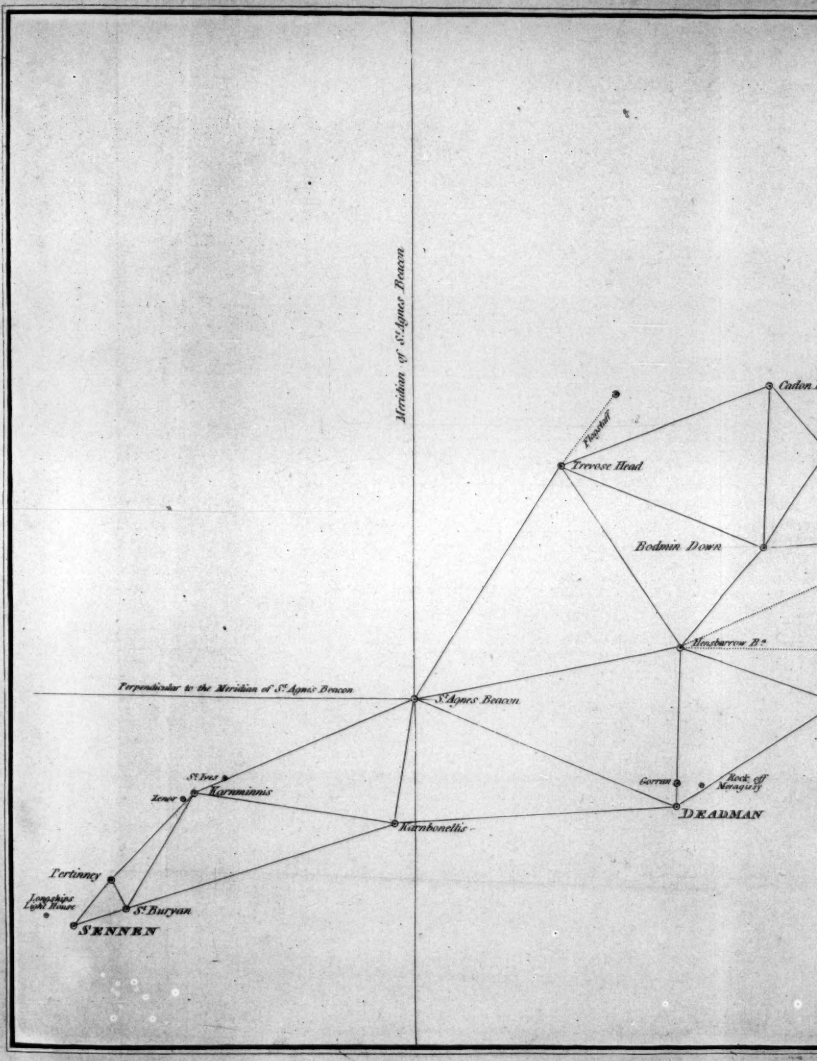

Dean Hill
Wingreen
Bull Barrow
Fig. 1
BLACK DOWN
Nine Barrow Down
DUNNOSE

P
Fig. 2
R
T
B

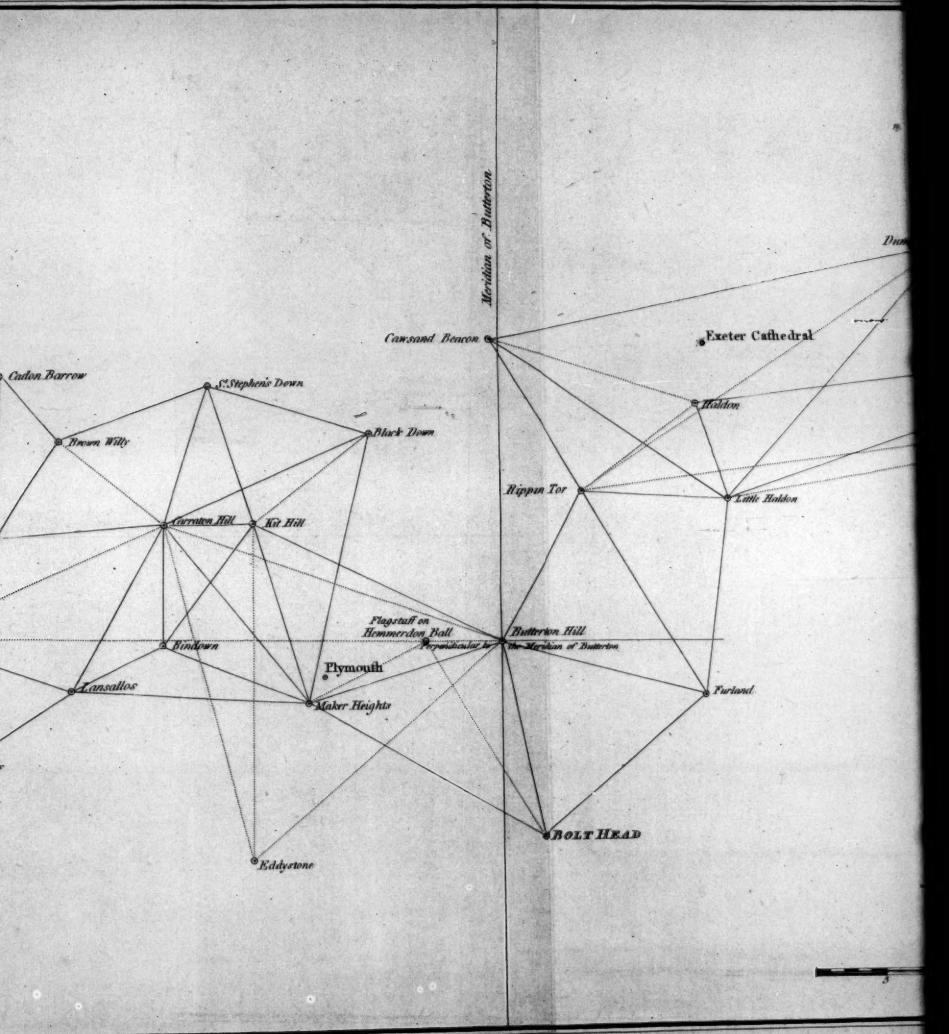

P
Fig. 3
B
H
A


Z
Fig. 4
B
F
C
E
D
A

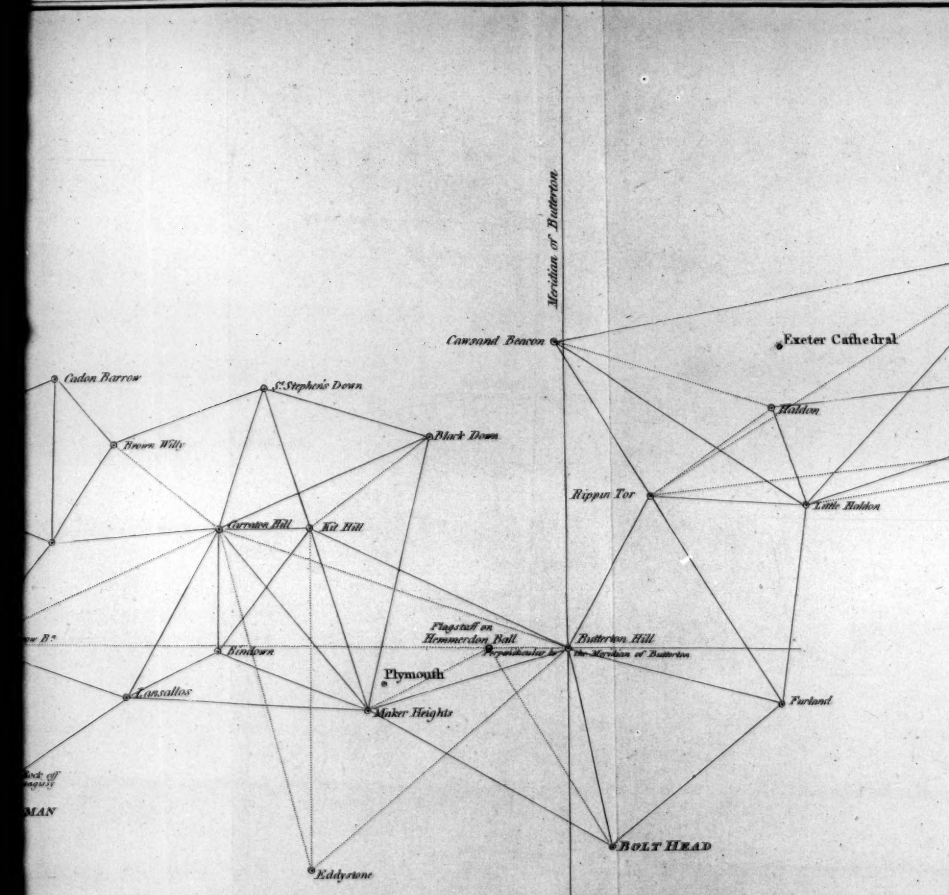
PLAN of the PRINCIPAL TRIANGLES in the TRIGO



IGONOMETRICAL SURVEY, 1795. 1796. 1799 shewing the DIRECTIONS of the MERIDIANS at BL

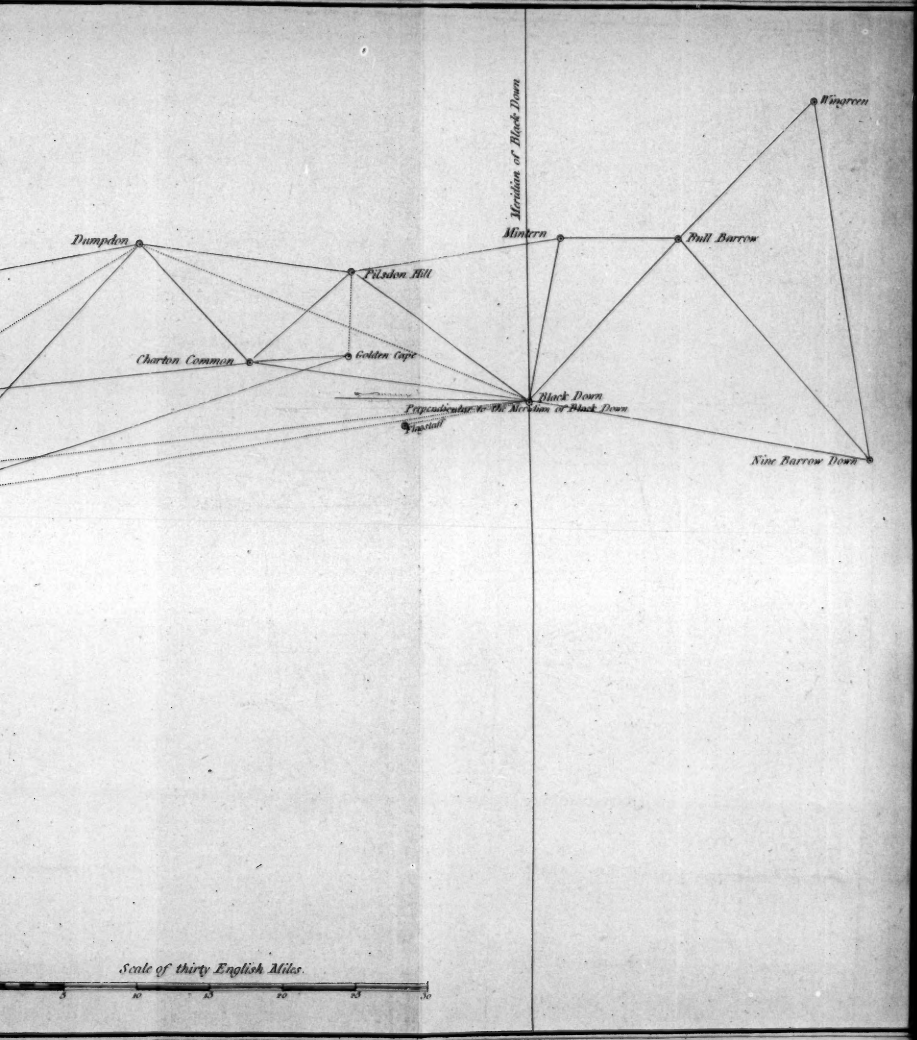


TRIGONOMETRICAL SURVEY, 1795. 1796. 1799 shewing the DIRECTIONS of the MERIDIANS at

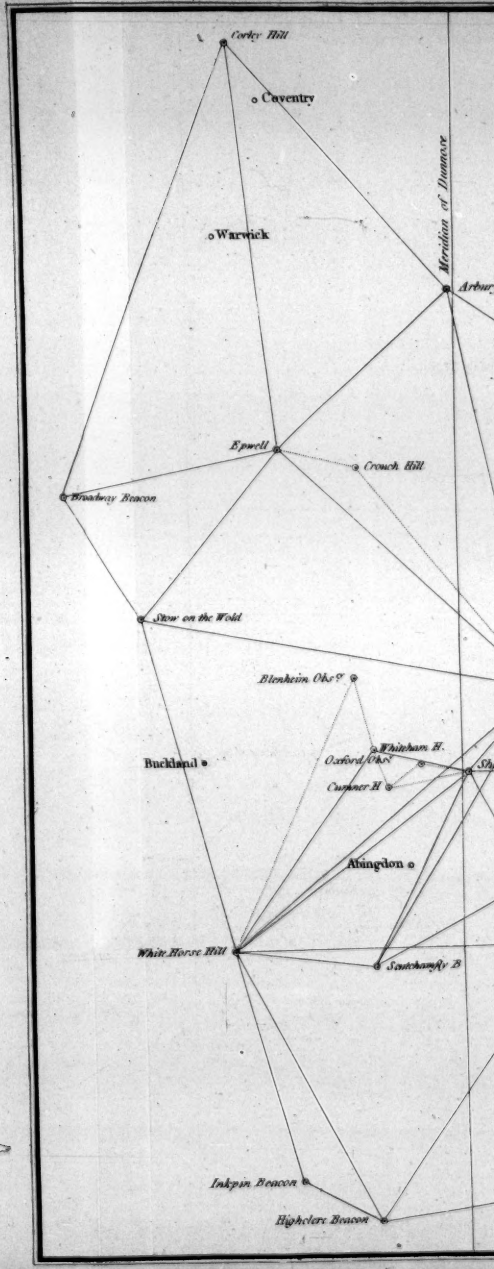


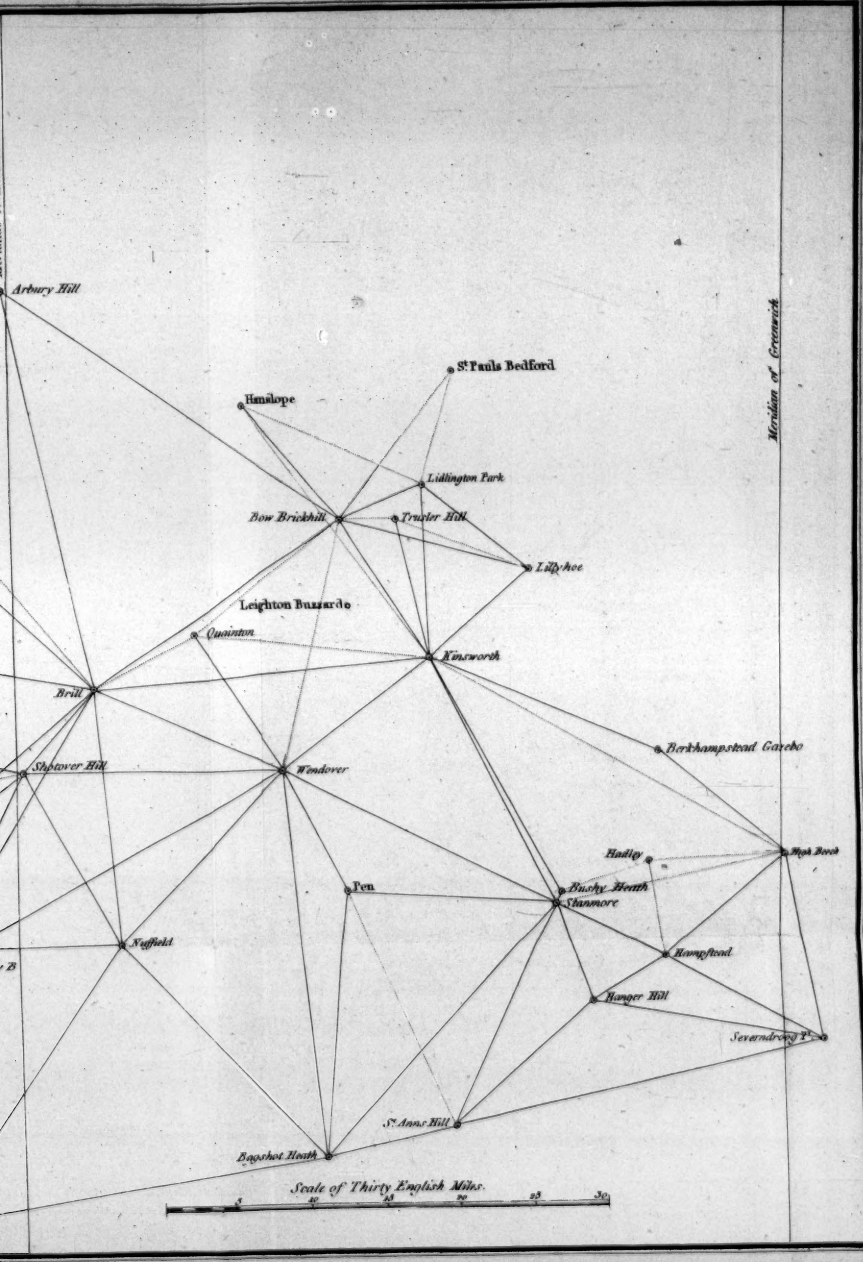
s at BLACK DOWN, BUTTERTON and S^T AGNES BEACON.

Philos. Trans. MDCCC. Plate XXVII. p. 726



PLAN of the PRINCIPAL




Arbury Hill
St Pauls Bedford
Meridian of Greenwich
Hmslope
Lidlington Park
Bow Brickhill
Truster Hill
Lilly hoe
Leighton Buzzard
Quainton
Kinsworth
Brill
Berkhampstead Garcho
Shotover Hill
Wendover
Hadley
Pen
Bushy Heath
Stanmore
Nuffield
Hampstead
Hanger Hill
Severndroog Pt
St Anns Hill
Bagshot Heath
Scale of Thirty English Miles.
5
10
15
20
25
30

Refractions found from the preceding Angles of Elevation and Depression.

1. Arc. White Horse Hill & Whitecham Hill.				2. Arc. Brill and Arbury Hill.				3. Arc. Arbury Hill and Wendover.				4. Arc. Broadway Beacon and Epwell.			
Hours.	Refraction. pts. cont. arc.	Barom.	Therm.	Hours.	Refraction. pts. cont. arc.	Barom.	Therm	Hours.	Refraction. pts. cont. arc.	Barom.	Therm.	Hours.	Refraction. pts. cont. arc.	Barom.	Therm.
		in. pts.	°			in. pts.	°			in. pts.	°			in. pts.	°
3 P.M.	1/10,8	29,5	58,0	9 A.M.	1/10,9	29,1	63,2	5	1/10,8	28,8	54,6	2	1/35,1	29,2	54,1
4	1/9,4	29,5	61,0	10	1/10,7	29,2	68,7	6	1/11,6	28,8	61,5	3	1/51,0	57,5	58,2
5	1/10,4	29,5	58,1	11	1/10,7	29,2	68,1					4	1/8,6	29,1	57,5
6	1/10,4	29,5	57,0	12	1/10,4	29,2	67,6								
7	1/10,8	29,5	57,0	3 P.M.	1/10,4	29,2	72,5								
8	1/9,5	29,6	55,6	4	1/7,4	29,2	72,0								
9	1/10,6	29,6	54,5	9	1/9,8	29,2	62,3								
10	1/14,0	29,5	54,3												

On examining the refractions obtained on the first arc, we perceive them to have been tolerably regular from 3 o'clock till 8; the mean being $\frac{1}{10.1}$ part of the contained arc. The height of Whiteham Hill is 576 feet, and that of White Horse Hill 893 feet, above the level of the sea; the ray passes, therefore, through a tract of air considerably elevated, as the country between the stations is, for the most part, flat and low.

The air is not often clear enough, or sufficiently free from tremulous motions, for these delicate observations. On the present occasion, however, the state of it was highly fit for the purpose; and, as care was taken, I am of opinion an error of more than 3″, taking that of the arch of altitude into the account, cannot have obtained in any of the angles. The refractions at 9 and 10 o'clock are less than at the preceding hours; but this does not appear to have been owing to any change in the refractive power of the air throughout the whole extent of the ray, because the depression of Whiteham Hill, from the other station, varied little at those hours. These changes in the observed angles of elevation at Whiteham, (44″ and 42″ being the differences,) *without* corresponding ones at White Horse Hill, prove that some *partial* alteration, from floating strata, had taken place in the refraction near the former station. Whoever considers the matter, must perceive a case may be constructed in which this will take place, causing a great variation in one of the angles, whilst the other *apparently* remains the same: and this suggested the idea, that to afford any accurate conclusions in this way, a long series of observations would be necessary. It furthermore appears, that dew could not have caused these differences at Whiteham Hill, since the same cause would equally operate to vary the observed angles at White Horse Hill; but those remained nearly the same.

The refractions on the second and third arcs, I consider as most accurate, on account of the great distance between the stations; and also as more to be depended on, from the circumstance of the ray generally passing 900 feet above the ground.

The fourth arc affords another instance of the refraction varying at one station, and remaining constant at the other. This, no doubt, was owing to the intervention of some partial stratum of air, nearer to Epwell than Broadway Beacon. The refractions, deduced from these contemporary observations are certainly inconclusive. The mean refractions, (neglecting the fourth arc) brought under one point of view, will be as follows.

Arcs.	Mean height of ray above the sea.	Refraction. Propl. pt.	Barom.	Therm.
	Feet.		in. pts.	
1. White Horse Hill and Whiteham	734	$\frac{1}{10,9}$	29.5	57,8
2. Arbury H. and Brill, 5 first refracs.	774	$\frac{1}{10,6}$	29,2	67,8
3. Arbury Hill and Wendover -	854	$\frac{1}{11,2}$	28,8	58,1

If the air had been in a quiescent state, previous to and also at the times when these observations were made, it might be expected that the differences of altitudes in the stations would be obtained, tolerably near the truth, *barometrically*. The remarks in the tables appertaining to the first and second arcs, shew that such opportunities offered; but those which belong to the third, prove the wind to have been fresh; and, as the space between the stations which constitute the extremities of that arc is 34 miles, nearly, it is not to be expected that a true result should be obtained. The differences of altitudes of the stations constituting the extremities of the two first arcs, obtained by means of the observed angles of elevation and depression, as well

as from the heights of the mercury in the barometer, will be as follows.

Arcs.	Obs. Ang.	Barom.	Diff.
1	317	282	35
2	60	15	45

The little done on this subject, points out the necessity of doing more; it therefore remains with me to observe, that I shall lose no opportunity of employing the apparatus committed to my charge in the best and most diligent manner, both as relating to matters of refraction, and to all others connected with the Trigonometrical Survey.

In the Introduction, page 540, it is stated that this Account would be comprized in three Sections, but it was afterwards thought more convenient to divide it into four.

In Page 583, line penult. *dele* and Prittlewell.

—— 665, —— 14, *for* 1798, *read* 1772.

PRESENTS

RECEIVED BY THE

ROYAL SOCIETY,

From November 1799 to July 1800;

WITH THE

NAMES OF THE DONORS.

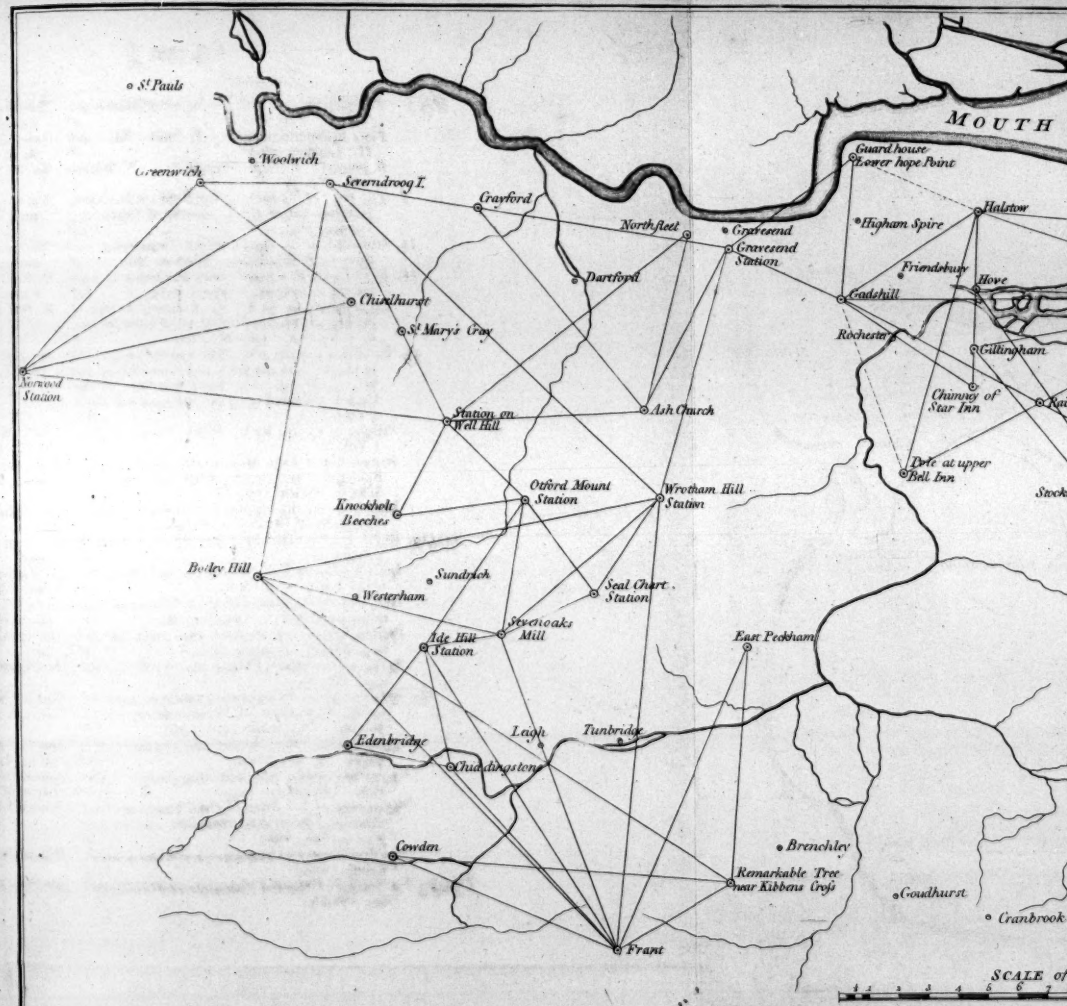
1799.	PRESENTS.	DONORS.
Nov. 7.	Mémoires de l'Académie Royale des Sciences et Belles Lettres, 1794 et 1795. Berlin, 1799. 4°	The Royal Academy of Sciences of Berlin.
	Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce. Vol. XVII. London, 1799. 8°	The Society for the Encouragement of Arts, Manufactures, and Commerce.
	A third Dissertation on Fever. Part II. by G. Fordyce. London, 1799. 8°	George Fordyce, M. D. F. R. S.
	Catalogues of the Birds, Shells, and some of the more rare Plants of Dorsetshire. London, 1799. 1ol.	Richard Pulteney, M. D. F. R. S.
	View of the Russian Empire during the Reign of Catherine II. by W. Tooke. London, 1799. 3 Vols. 8°	The Rev. William Tooke, F. R. S.
	Atlas Cœlestis, Tab. III. et V—XIV.	Mr. J. E. Bode, F. R. S.
	Traité de Mécanique Celeste, par P. S. Laplace. Paris, An 7. Tomes II. 4°	M. Laplace, F. R. S.
	Exposition du Système du Monde, par P. S. Laplace. 2de Edition. Paris, an 7. 4°	
	Bibliotheque Britannique, No. 79—88.	Professor Pictet, F. R. S.
	A Portrait of the late Mr. John Smeaton, painted by M. Brown.	Alexander Aubert, Esq. F. R. S.
	A. Comparetti, Observationes Opticæ de Luce inflexa et Coloribus. Patavii, 1787. 4°	Professor Comparetti, of Padua.
	Theorie des Vents et des Ondes, par M. de la Coudraye. Copenhague, 1796. 8°	Chev. de la Coudraye.
	Nachricht von einer merkwürdigen literarischen Betrügerey, von J. Hager. Erlangen, 1799. 4°	Dr. Hager.
	Rélation d'une insigne Imposture litteraire, par M. Hager. Erlang, 1799. 4°	
	Memoir on the extraneous Fossils denominated Mammoth Bones, by G. Turner. Philadelphia, 1799. 4°	Mr. George Turner.

	PRESENTS.		DONORS.
	The London Catalogue of Books. London, 1799.	8°	Mr. William Bent.
	A Treatise on the Venereal Rose. London, 1799.	8°	William Butter, M. D.
	A Journal of Natural Philosophy, by W. Nicholson. No. 29—33.		Mr. William Nicholson.
Nov. 14.	A Series of Engravings to illustrate the Morbid Anatomy of the Human Body, by M. Baillie. Fascic. II. London, 1799.	4°	Matthew Baillie, M. D. F. R. S.
	A complete System of Astronomy, by S. Vince. Vol. II. Cambridge, 1799.	4°	The Rev. Samuel Vince, A. M. F. R. S.
	Tabulæ Neurologicæ, Auctore A. Scarpa. Ticini, 1794.	fol.	Professor Scarpa, F. R. S.
	Fragments of the Natural History of Pennsylvania, by B. S. Barton. Philadelphia, 1799.	fol.	Professor Barton, of Philadelphia.
	Description d'une Amethyste du Cabinet des Pierres gravées de l'Empereur de toutes les Russies. St. Petersbourg, 1798.	8°	Mr. Koehler, of Petersburg.
Dec. 5.	Pharmacopœa Borussica. Berolini, 1799.	4°	Professor Formey, and Professor Klaproth, F. R. S.
	Nouvelles Tables Trigonométriques, par J. P. Hobert et L. Ideler. Berlin, 1799.	8°	Professor Hobert, and M. Ideler.
	Annals of Medicine for the Year 1798, by A. Duncan, sen. and A. Duncan, jun. Vol. III. Edinburgh, 1799.	8°	Andrew Duncan, sen. M. D. and Andrew Duncan, jun. M. D.
	Etchings, representing the best Examples of ancient ornamental Architecture, by C. H. Tatham. London, 1799.	fol.	Mr. Charles Heathcote Tatham.
12.	An Essay on the Preservation of shipwrecked Mariners, by A. Fothergill. London, 1799.	8°	Anthony Fothergill, M. D. F. R. S.
	Courbes decrites par des Projectiles dans les Milieux résistans, calculées par le Lieut. Gen. Komarzewsky. MS.		Lieut. General Komarzewsky, F. R. S.
	A general View of the Nature and Objects of Chemistry, by W. Henry. Manchester, 1799.	8°	Mr. William Henry.
	A Journal of Natural Philosophy, by W. Nicholson. No. 34.		Mr. William Nicholson.
19.	Bibliotheque Britannique. No. 89, 90.		Professor Pictet, F. R. S.
1800.			
Jan. 9.	A Journal of Natural Philosophy, by W. Nicholson. No. 35.		Mr. William Nicholson.
16.	Memoirs of the Medical Society of London, Vol. V. London, 1799.	8°	The Medical Society of London.
	Experiments with the Metallic Tractors, edited by B. D. Perkins. London, 1799.	8°	Mr. B. D. Perkins.
	Of the Imagination as a Cause, and as a Cure of Disorders of the Body, exemplified by fictitious Tractors, by J. Haygarth. Bath, 1800.	8°	John Haygarth, M. D. F. R. S.
23.	Observations on the Cure of the curved Spine, by J. Earle. London, 1799.	8°	James Earle, Esq. F. R. S.
	An Essay on the Means of lessening the Effects of Fire on the Human Body, by J. Earle. London, 1799.	8°	
	Pantographia, by E. Fry. London, 1799.	8°	Mr. Edmund Fry.

	PRESENTS.	DONORS.
Feb. 6.	Prospectus of the Royal Institution of Great Britain. London. 8°	The Managers of the Royal Institution.
	The Cambrian Register for the Years 1795 and 1796. London, 1796, 1799. 8°	John Symmons, Esq. F. R. S.
	Bibliotheque Britannique. No. 91—94.	Professor Pictet, F.R.S.
	A Meteorological Journal of the Year 1799, kept in London by W. Bent. London. 8°	Mr. William Bent.
	A Journal of Natural Philosophy, by W. Nicholson. No 36.	Mr. William Nicholson.
Feb. 13.	A Translation of the Table of Chemical Nomenclature, proposed by de Guyton, Lavoisier, Bertholet, and Fourcroy. London, 1799. 4°	George Pearson, M. D. F. R. S.
	Philosophie de l'Univers. 3me edition. Paris, an 7. 8°	M. Du Pont, de l'Institut. National de France.
20.	Nova Acta Academiæ Scientiarum Imperialis Petropolitanæ, Tom. XI. Petropoli, 1798. 4°	The Imperial Academy of Sciences of Petersburg.
	Abhandlung, wie mit neuerfundenen Luftwechselmaschinen die auf Bergwercken vorkommenden bösen Wetter wegzuraumen sind, bey C. W. Böbert. St. Petersburg, 1797. 4°	
	Transactions of the Linnean Society. Vol. V. London, 1800. 4°	The Linnean Society.
27.	A Series of Engravings to illustrate the Morbid Anatomy of the Human Body, by M. Baillie. Fascic. III. London, 1800. 4°	Matthew Baillie, M. D. F. R. S.
Mar. 6.	The History of the Helvetic Confederacy, in 2 Vols. London, 1800. 4°	Joseph Planta, Esq. Sec. R. S.
13.	Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge. Vol. II. London, 1800. 8°	The Society for the Improvement of Medical and Chirurgical Knowledge.
	Bibliotheque Britannique. No. 95, 96.	Professor Pictet, F.R.S.
27.	Account of Antiquities discovered at Ribchester, by C. Townley. fol.	The Society of Antiquaries.
	General View of the Agriculture of the County of Westmoreland, by A. Pringle. Edinburgh, 1794. 4°	George Chalmers, Esq. F. R. S.
	C. P. Thunberg, Dissertatio de Erica, cuante R. A. Salisbury. Featherstone, 1800. 4°	Richard Anthony Salisbury, Esq. F. R. S.
	Annals of Medicine for the Year 1799, by A. Duncan, sen. and A. Duncan, jun. Vol. IV. Edinburgh. 8°	Andrew Duncan, sen. M. D. and Andrew Duncan, jun. M. D.
April 3.	The Naturalist's and Traveller's Companion, by J. C. Lettsom. 3d edition. London, 1799. 8°	John Coakley Lettsom, M. D. F. R. S.
	Medical Facts and Observations. Vol. VIII. London, 1800. 8°	Samuel Foart Simmons, M. D. F. R. S.
	Observations on a Tour through the Highlands of Scotland, by T. Garnett. London, 1800. 2 Vols. 4°	T. Garnett, M. D.
	A Journal of Natural Philosophy, by W. Nicholson. No. 38.	Mr. William Nicholson.
24.	Plants of the Coast of Coromandel, by W. Roxburgh. Vol. II. No. 2.	Court of Directors of the East India Company.

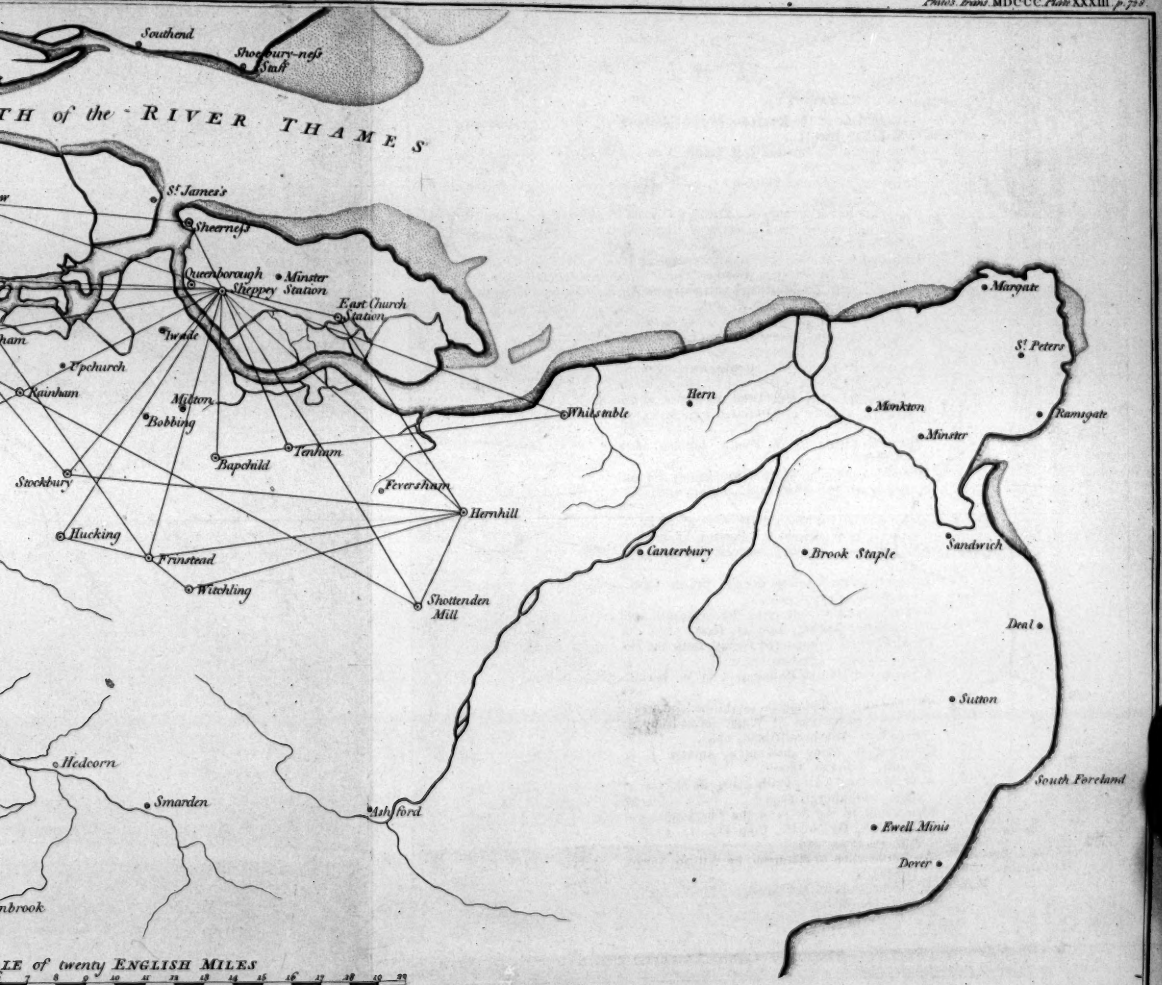
	PRESENTS.	DONORS.
May 1.	Transactions of the Royal Society of Edinburgh. Vol. V. Part. I. 1799. 4°	The Royal Society of Edinburgh.
	Flora Britannica, auctore J. E. Smith. Vol. I. and II. London, 1800. 8°	James Edward Smith, M. D. F. R. S.
	A Journal of Natural Philosophy, by W. Nicholson. No. 39.	Mr. William Nicholson.
8.	The Duty of not running into Debt; a Discourse, preached before the University of Cambridge. London, 1800. 8°	The Rev. George Whitmore, B. D. F. R. S.
15.	Observations on the Northern Circumpolar Region, by F. Wollaston. London, 1800. 4°	The Rev. Francis Wollaston, LL. B. F. R. S.
22.	A. Comparetti, Observationes anatomicæ de Aure interna comparata. Patavii, 1789. 4°	Professor Comparetti of Padua.
	Observations on the Effects of various Articles of the Materia Medica in the Cure of Lues Venerea, by J. Pearson. London, 1800. 8°	Mr. Pearson.
29.	Seventeen Reports of the Commissioners appointed to inquire into the State and Condition of the Woods, Forests, and Land Revenues of the Crown. Ordered to be printed 1792 and 1793. 2 Vols. fol.	Sir John Call, Bart. F. R. S.
	History of Russia, by W. Tooke. London, 1800. 2 Vols. 8°	The Rev. William Tooke, F. R. S.
	Beweis dass Johann Mayow den grund zur antiphlogistischen chemie gelegt hat, von J. A. Scherer. Wien, 1793. 8°	The Rev. Herbert Marsh, B. D.
	Memorials on the Medical Department of Naval Service, by W. Renwick. Portsea, 1800. 8°	Mr. William Renwick.
June 19.	Royal Humane Society. Annual Report, 1800. London. 8°	The Royal Humane Society.
	Letters from the Cardinal Borgia, and the Cardinal of York, 1799, 1800. 4°	Sir John Cox Hippisley, Bart. F. R. S.
	New Observations concerning the Colours of thin transparent Bodies. London, 1800. 8°	Gibbes Walker Jordan, Esq. F. R. S.
	Persian Lyrics, or scattered Poems, from the Diwan-i-Hafiz. London, 1800. 4°	John Haddon Hindley, Esq.
	A Journal of Natural Philosophy, by W. Nicholson. No. 40.	Mr. William Nicholson.
26.	The Doctrine of Phlogiston established, and that of the Compoution of Water refuted, by J. Priestley. Northumberland, 1800. 8°	The Rev. Joseph Priestley, LL. D. F. R. S.
	Compendium Floræ Britannicæ, auctore J. E. Smith. Londini, 1800. 8°	James Edward Smith, M. D. F. R. S.
	A. H. Macdonald, Disputatio inaug. de Necrosi ac Callo. Edinburgi, 1799. 8°	Alexander Herman Macdonald, M. D.
	Memoranda of the State of the Thermometer at Sidmouth, Devonshire, from Dec. 11, 1799 to Apr. 15, 1800. MS. 4°	White Melville, Esq.
	An Introduction to Harmony, by William Shield. London, 1800. 4°	William Shield, Esq.
July 3.	A Journal of Natural Philosophy, by W. Nicholson. No. 41.	Mr. William Nicholson.

TRIANGLES for the Survey of t

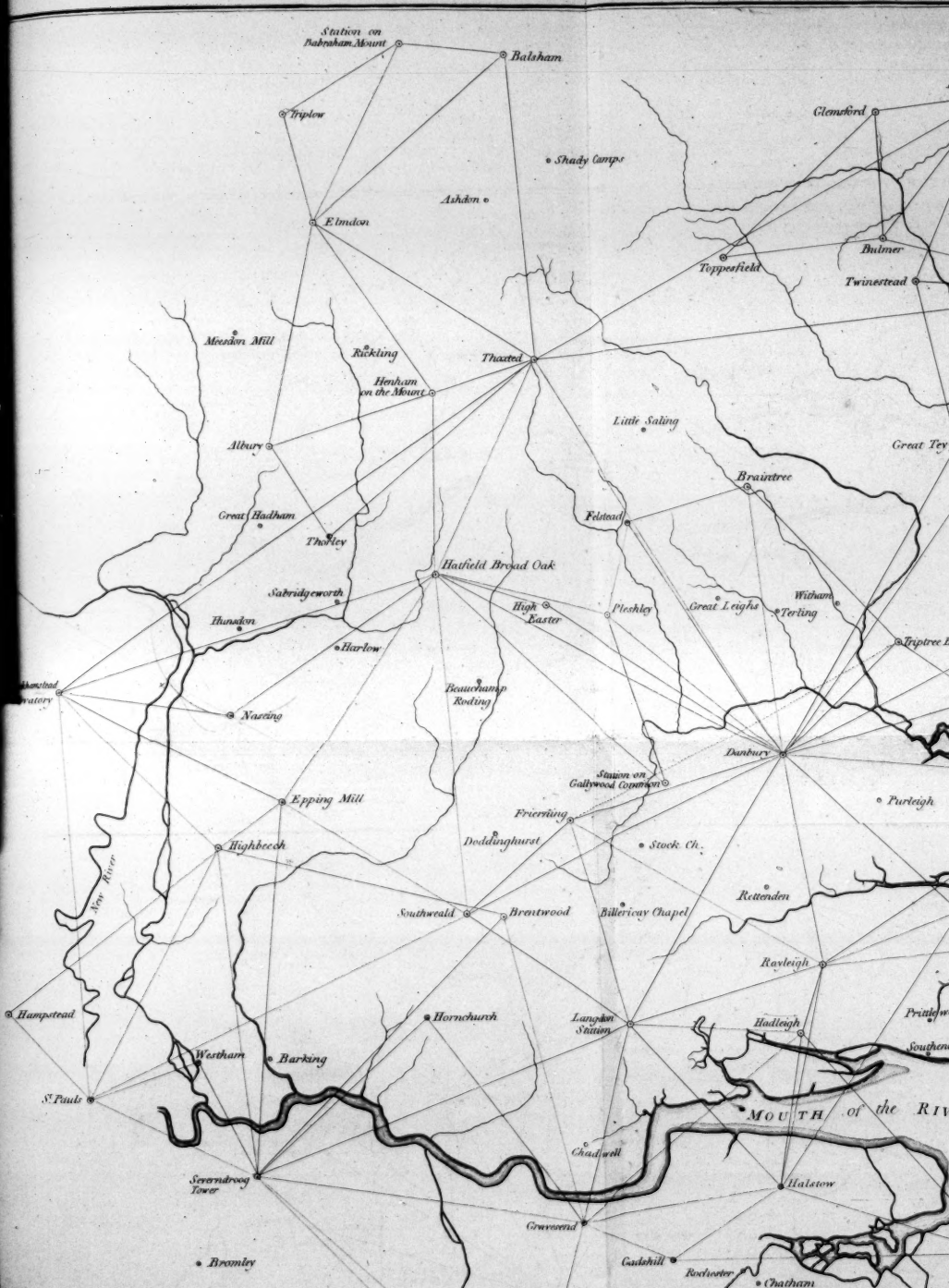


of the Northern & Western parts of KENT, 1799.

Philos. Trans. MDCCC. Plate XXXIII. p. 738.



TRIANGLES for the Survey of ESSEX and parts of



Philos. Trans. MDCCC. Plate XXXII. p. 720.

Orfley
Henley
Lavenham
Naughton
Woodbridge
Putley
Ipswich
Rushmere
Updock
Bawdsey
Falkenham
Stoke
Tattingstone
Brantham
Felixstow
Signal Staff
Landguard Fort
Harwich
Dover Court
Little Bromley
Great Tey
St Mary's Colchester
Little Bentley
Walton Tower or Sea Mark
Thorp
Finton
Signal Staff
Layer Marney
Brightlingsea
Peldon
Great Clacton
Signal Staff
Staff on St Osyth Priory
St Osyth Point
Signal Staff
Triptree Heath
West Mersey
Tolesbunt Major
Bradwell Signal Staff
Tillingham
Southminster
Crouch Signal Staff
Canewdon
Foulness Chapel
Shoebury-ness Staff
RIVER THAMES
Sheerness
Sheppey
Margate
St Peters
Ramsgate
Monkton
Hern
Whitstable
Milton
Feversham
Boughton
Sandwich
ENGLISH MILES

INDEX

TO THE

PHILOSOPHICAL TRANSACTIONS

FOR THE YEAR 1800.

A — page

Acid, carbonic, remarks on, 202
——— *fluoric*, remarks on, 202
——— *muriatic*, experiments to decompose it, 188
Air, on the quantity of it discharged through an aperture, 107
——— on the direction and velocity of a stream of it, 109
Albumen, experiments on, 375, 387, 396
Alcyonium, experiments on various species of, 854, 864
Antipathes, experiments on various species of, 854, 864
Arteries, on a peculiarity in those of slow-moving animals, 98
Astronomy, physical, second appendix to the improved solution of a problem in, 86

B

Barker, Thomas, Esq. Abstract of a register of the barometer, thermometer, and rain, at Lyndon, in Rutland, for the year 1798, 46
Barometer, Register of, at Lyndon, in Rutland, 46
Birds, on their organ of hearing, 6, 16
Blood, remarks on, 401
Brachyous didactylus, remarks on its arteries, 109
——— *tridactylus*, remarks on its arteries, 99
Brightness, remarks on, 51

C

Candle, on the reflection of its heat, 297
——— on the refraction of its heat, 308
Carlisle, Mr. Anthony. Account of a peculiarity in the distribution of the arteries sent to the limbs of slow-moving animals; together with some other similar facts, 98
Cartilage, experiments on, 883
Cavities, sonorous, observations on, 116
Chords, on their vibrations, 184
Cochlea of the Ear, remarks on, 18

page

Cooper, Mr. Astley. Observations on the effects which take place from the destruction of the membrana tympani of the ear, 151
Corallina Opuntia, experiments on, - - 334, 362
Cruicksbank, Mr. on the matter remaining after the explosion of gunpowder, - - - - - 237

E

Ear, on its membrana tympani, - - - 1, 151
—— on the uses of its different parts, - - - 8
Eel, electrical, on its electric apparatus, - - 429
Electricity, its effect on carbonic acid, - - - 202
—— —— on fluoric acid, - - - 202
—— —— on muriatic acid, - - - 190
—— on that excited by the contact of conducting substances, 403
Elephant, on its organ of hearing, - - - 2, 19

F

Feather, experiments on, - - - 372
Fire-heat, on its reflection, - - - 300, 305
—— on its refraction, - - - 311, 315
—— on its transmission, - - - 476, 524
Fish, experiments on their light, - - - 168
—— on their organ of hearing, - - - 15
Flame-heat, on its transmission, - - - 462, 524
Fluids, elastic, on the vibrations of different ones, - 124
Flustra foliacea, experiments on, - - 334, 362
Focus, on that of the rays of heat, - - - 444

G

Gas, muriatic acid, effects of electricity on it, - - 190
—— effects of electrifying it with inflammable substances, - - - - - 194
Gelatin, remarks on, - - - 366, 376, 396
Glow-worms, experiments on their light, - - 178, 180
Gorgonia, experiments on various species of, - 338, 362
Gunpowder, comparison of its strength with that of fulminating mercury, - - - 207, 236
—— on the matter remaining after its explosion, - 237

H

Hair, remarks on, - - - 371
Hatchett, Charles, Esq. Chemical experiments on zoophytes; with some observations on the component parts of membrane, - - - 327
Heat, on its different refrangibility, - - 255, 271, 438
—— on the solar and terrestrial rays which occasion it, 293, 437

page
Heat, on the laws to which it is subject, - - - 296
—— on the reflection of that of the sun, - - 296, 298, 302
—— —— of that of a candle, - - - 297
—— —— of that of hot iron, - - - 299, 306
—— —— of that of fire, - - - 300, 305
—— on the refraction of that of the sun, - 284, 308, 310, 317
—— —— of that of a candle, - - - 308
—— —— of that of fire, - - 311, 315
—— —— of that of hot iron, - - 313, 319
—— on the focus of its rays, - - - - 444
—— on the transmission of heat-making rays, - 445, 520
—— —— of terrestrial flame-heat, - - 462, 524
—— —— of the solar heat which is of equal refrangibility with red rays, - - 470, 520
—— —— of that of fire, - - 476, 524
—— —— of invisible solar heat, - - 485, 520
—— —— of invisible terrestrial heat, - 490, 524
—— on its transmission through colourless substances, - 449
—— —— through coloured glasses, - - 453
—— —— through liquids, - - - 456
—— —— through scattering substances, - 458
—— on the scattering of solar heat, - - - 497
—— whether it be occasioned by the same rays as light, or by different ones, - - - 506
Heavens, on the time it would take to sweep them, - - 84
Hellins, the Rev. John. A second appendix to the improved solution of a problem in physical astronomy, inserted in the Philosophical Transactions for the year 1798, containing some further remarks, and improved formulæ for computing the coefficients A and B; by which the arithmetical work is considerably shortened and facilitated, - - - - - 86
Henry, Mr. William. Account of a series of experiments, undertaken with the view of decomposing the muriatic acid, - 188
Herrings, experiments on their light, - - - 163
Herschel, William, LL. D. On the power of penetrating into space by telescopes; with a comparative determination of the extent of that power in natural vision, and in telescopes of various sizes and constructions; illustrated by select observations, 49
—— —— —— Investigation of the powers of the prismatic colours to heat and illuminate objects; with remarks, that prove the different refrangibility of radiant heat. To which is added, an inquiry into the method of viewing the sun advantageously, with telescopes of large apertures and high magnifying powers, - - - - - 255

page

HERSCHEL, WILLIAM, LL.D. Experiments on the refrangibility of the invisible rays of the sun, - - - - 284

——— Experiments on the solar, and on the terrestrial rays that occasion heat; with a comparative view of the laws to which light and heat, or rather the rays which occasion them, are subject, in order to determine whether they are the same, or different, - - - - - 293, 437

HOME, EVERARD, Esq. The Croonian Lecture. On the structure and uses of the membrana tympani of the ear, - - - - 1

——— Some additional remarks, on the mode of hearing in cases where the membrana tympani has been destroyed, - - - - - 159

——— Some observations on the head of the Ornithorhynchus paradoxus, - - - - - 432

Hoof, experiments on, - - - - - 374

Horn, experiments on, - - - - - 372

Horse, remarks on its membrana tympani, - - - - 6

HOWARD, EDWARD, Esq. On a new fulminating mercury, 204

HULME, NATHANIEL, M.D. Experiments and observations on the light which is spontaneously emitted, with some degree of permanency, from various bodies, - - - - 161

I

Illuminating power, on that of coloured rays, - - - 262

Images, on double ones caused by atmospherical refraction, - 239

Iron, hot, on the reflection of its heat, - - - 299, 306

——— on the refraction of its heat, - - - 313, 319

——— on the transmission of its heat, - - - 490, 524

Isis, experiments on various species of, - - - 335, 362

L

Latitude, on that of various places, - - 624, 644, 649, 655, 661

Lecture, Croonian, - - - - - - - 1

Lemur Loris, remarks on its arteries, - - - - 100

——— *tardigradus*, remarks on its arteries, - - - - 98

Light, experiments and inquiries respecting it, - - - - 106

——— on the analogy between it and sound, - - - - 185

——— on the laws to which it is subject, - - - - 295

——— whether it be occasioned by the same rays as heat, or by different ones, - - - - - - 506

——— on the transmission of terrestrial scattered light through various substances, - - - - - 528

——— on the scattering of terrestrial light by various substances, 533

——— *spontaneous*, experiments and observations on the kind of light so called, - - - - - 161

page

Light, spontaneous, on the degree of putrescence necessary for its emission, - - - - 163
——— ——— on its separation and preservation, 165, 171
——— ——— on its extinction and revivification, 171, 173
——— ——— effects of motion on it, - - 175
——— ——— does not affect the thermometer, - - 176
——— ——— effects of cold on it, - - 177
——— ——— of heat on it, - - - 179
——— ——— of the human body and animal fluids on it, - - - - 184
Lion, remarks on its carotid artery, - - - 102
Longitude, on that of various places, - 624, 644, 649, 655, 661
Luminous bodies, remarks on, - - - 49

M

Mackerels, experiments on their light, - - 164
Madrepora, experiments on various species of, - 329, 360
Magnifying power, remarks on, - - - 68
Membrana tympani, on its structure and uses, - - 1
——— ——— on the effects arising from its destruction, 151, 159
Membrane, observations on its component parts, - 327, 366
Mercury, fulminating, on a new one, - - - 204
——— ——— method of preparing it, - - 205, 214
——— ——— effects of concussion on it, - - 206
——— ——— effects of electrical shocks on it, - 206
——— ——— temperature at which it explodes, - - 207
——— ——— comparison of its strength with that of gunpowder, - - - - 207, 236
——— ——— on its constituent principles, - 216
——— ——— on its characteristic properties, 230, 237
Millepora, experiments on various species of, - 331, 361
MORGAN, WILLIAM, Esq. On the method of determining, from the real probabilities of life, the values of contingent reversions in which three lives are involved in the survivorship, - 22
MUDGE, CAPTAIN WILLIAM. An account of the trigonometrical survey, carried on in the years 1797, 1798, and 1799, by order of Marquis Cornwallis, Master-General of the ordnance, 539
Muscular fibre, experiments on, - - - 391

N

Nail, iron, remarks on its appearance in a microscope, - 263
——— *human*, experiments on, - - - 374
Nicholson, Mr. Remarks on his opinion respecting the electric apparatus of the torpedo, &c. - - - 429

page

O

Ornithorbynchus paradoxus, observations on its head, - 432

P

Pipes, on their harmonic sounds, - - - - 121
Plates, on their vibrations, - - - - 140
Poker, hot, on the reflection of its heat, - - 299, 306
Presents received by the Royal Society, from November 1799 to July 1800, - - - - - 729
Prismatic colours, experiments on their heating power, - - 256
——— experiments on their illuminating power, 262
——— on the reflection of the heat that accompanies them, - - - - - 298
——— on the refraction of the heat that accompanies them, 310

R

Rain, register of, at Lyndon, in Rutland, - - - 46
Rays, on the solar and terrestrial ones that occasion heat, 293, 437
——— on the heating power of coloured ones, - - 256
——— on the illuminating power of coloured ones, - 262
——— on the reflection of invisible ones, - - 302, 304
——— on the refraction of invisible ones, - 284, 317, 319
——— on the condensation of invisible ones, - 304, 317
——— on the different refrangibility of those of heat, - 271, 438
——— on the focus of those of heat, - - - 444
——— on the transmission of heat-making ones, - 445, 520
——— ——— of invisible ones, - - 485, 520
——— whether light and heat be occasioned by the same, or by different ones, - - - - - 506
Refraction, atmospherical, on double images caused by it, - 239
——— extraordinary instance of, - 720
Reversions, contingent, on determining the values of those in which three lives are involved in the survivorship, - - 22
Rods, on their vibrations, - - - - 140

S

Scale, horny, experiments on, - - - - - 374
Scales of fish, experiments on, - - - - 373
Shells, observations on, - - - - - 327, 357
Skin, experiments on, - - - - 369, 378
Silver, on a fulminating one, - - - - 233
Soap, Chaptal's, remarks on, - - - - 392
Sound, experiments and inquiries respecting it, - - - 106
——— ocular evidence of its nature, - - - 115
——— on its velocity, - - - - - - 116

page

Sound, on sonorous cavities, - - - - 116
—— on its divergence, - - - - 118
—— on its decay, - - - - 120
—— on the harmonic sounds of pipes, - - 121
—— on the vibrations of different elastic fluids, - 124
—— on the analogy between light and sound, - - 125
—— on the coalescence of musical sounds, - - 130
—— on the frequency of vibrations constituting a given note, 133
—— on the vibrations of chords, - - - 134
—— on the vibrations of rods and plates, - - 140
—— on the human voice, - - - - 141
—— on the temperament of musical intervals, - 143
Space, on penetrating into it by telescopes, - - 49, 64
Sponge, experiments on various species of, - - 352, 364
Sun, on viewing it advantageously, - - 255, 273
—— on the refrangibility of its invisible rays, - - 284
—— See *Heat* and *Rays*.
Survey, trigonometrical, carried on in the years 1797, 1798, and 1799, account of, - - - - 539
———— particulars relating to the operations of the year 1797, - - - - 542
———— angles taken in the year 1797, - - 549
———— particulars relating to the operations of the year 1798, - - - - 555
———— angles taken in the year 1798, - - 559
———— particulars relating to the operations of the year 1799, - - - - 563
———— angles taken in the year 1799, - - 569
———— situations of the stations, - - 576
———— particulars relating to the base on Sedgemoor, 584
———— principal triangles, - 588, 677, 702
———— secondary triangles, - 610, 689, 703
———— latitudes and longitudes of various places, 624, 644, 649, 655, 661
———— bearings of the stations from various parallels, - - - - 643, 653
———— bearings of intersected objects from various parallels, - - - - 645, 657
———— survey of the northern and western parts of Kent, Essex, &c. - - - - 676
———— altitudes of the stations, - 710, 717
———— mean terrestrial refractions, - 715, 719
Survivorship. See *Reversions*.

page

T

Tadpoles, experiments on their light, - - 168
Tanning principle, remarks on, - - - - 382
Telescopes, on penetrating into space by them, - - 49, 64
——— on their magnifying power, - - - 68
——— on viewing the sun advantageously with them, 255, 273
——— experiments with them, - - - 277
Temperament, on that of musical intervals, - - - 143
Thermometer, register of, at Lyndon, in Rutland, - - 46
Thermometers, on their sensibility, - - - 447
Torpedo, remarks on its electric apparatus, - 416, 429
Tortoise shell, experiments on, - - - 375, 397
Trigonometrical survey. See *Survey*.
Tubipora musica, experiments on, - - - 333, 362

V

Vibrations, on those of different elastic fluids, - - - 124
——— on the frequency of those constituting a given note, 133
——— on those of chords, - - - - 134
——— on those of rods and plates, - - - 140
Vision, observations on, - - - - - 49
Voice, human, remarks on, - - - - 141
VOLTA, Mr. ALEXANDER. On the electricity excited by the mere contact of conducting substances of different kinds, - 403

W

Weather of 1798, remarks on, - - - - 47
Willow, remarks on its bark, - - - - 382
WOLLASTON, WILLIAM HYDE, M. D. On double images caused by atmospherical refraction, - - - 239
Wood, shining, experiments on its light, - - 177, 179

Y

Yolk of egg, remarks on, - - - - 389
YOUNG, THOMAS, M. D. Outlines of experiments and inquiries respecting sound and light, - - - - 106

Z

Zoophytes, chemical experiments on, - - - 327

From the Press of
W. BULMER & Co.
Cleveland-Row, St. James's.